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DOCUMENTING CRITICAL MASS FOR THE USE OF INTERACTIVE INFORMATION TECHNOLOGIES IN SCHOOLS, COLLEGES, AND DEPARTMENTS OF EDUCATION

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy

Donald D. Tharp

College of Education
Division of Educational Psychology, Statistics and Technology
Educational Technology Program

August, 1997

THIS DISSERTATION WAS SPONSORED

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ABSTRACT

Tharp, Donald D. Documenting critical mass for the use of interactive information technologies in schools, colleges, and departments of education. Published Doctor of Philosophy dissertation, University of Northern Colorado, 1997.

The purpose of this study was to advance the knowledge base of critical mass for the use of information technologies within Schools, Colleges, and Departments of Education (SCDEs). Additionally, this study examined the contingent innovation-decision of SCDE faculty users and SCDE student users in light of the existence of the required infrastructure for the use of interactive information technologies.

The design of this study was a sample survey design. Professional teacher education institutions which are members of the American Association of Colleges for Teacher Education (AACTE) were sampled for this study. The 1996 SCDE Technology Survey was used to collect data relating to SCDE faculty use, SCDE student use, and SCDE institutional capacity for information technologies. The 1996 return rate was 465 out of 744 SCDE institutions (63%). Achievement of critical mass was based on the number of institutions identified as combined SCDE faculty and student users, SCDE faculty users, SCDE student users, and SCDE infrastructure provider institutions. Critical mass for all SCDE user groups and SCDE infrastructure provider institutions was reached when the user percentage was greater than or equal to 16%. Additionally, a Chi-square test of independence was conducted to determine if the proportions of users and nonusers were equivalent for adequate and inadequate information technologies infrastructure.

Results confirm critical mass has been achieved in SCDE use of information technologies and for the provision of adequate infrastructure for the use of information technologies. Additionally, regarding contingent innovation-decisions, the statistical analyses resulted in significant differences in the number of institutions identified as

combined SCDE faculty and student users and SCDE faculty users with adequate infrastructure. Results of this study document that SCDEs which have provided adequate information technologies infrastructure also have statistically greater proportions of users for both combined SCDE faculty and students and SCDE faculty.

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CHAPTER I

INTRODUCTION

Technology plays an integral role in the American way of life. Computers, television, telephones and telecommunications influence work and play. These technological tools and required infrastructure have become essential for the effective operation of businesses and are a primary means for information acquisition. Unfortunately, these tools come with a price: an increased demand for well trained and highly educated personnel (DeLoughry, 1993). The challenge to meet this demand falls heavily upon American educators at all levels, pre-K through higher education. All educators, then, must prepare themselves for this challenge.

Educators at all levels who wish to adopt information technologies cannot do so without adequate infrastructure. Therefore, an educator's decision to adopt information technologies is contingent upon administration supplying the necessary equipment, training, and support that allows educators the opportunity to implement information technologies into the classroom (Awbrey, 1996). Though adoption of information technologies affects all levels of education, this study focuses on the contingent adoption of information technologies by higher education, specifically Schools, Colleges, and Departments of Education (SCDEs).

The adoption process requires time and carefully planned strategies to reach the critical mass of the potential user population. One model that SCDEs can utilize to facilitate reaching critical mass as they begin to adopt information technologies is the continuation training model used in the business world. The continuation training model is designed to train SCDE preservice teachers to use technology to (a) teach, (b) perform administrative

tasks, (c) communicate with parents, and (d) continue their professional development (MacKnight, 1995). According to Cummings (1996), the ability to train preservice teachers to use information technologies is contingent upon SCDEs providing the necessary equipment (e.g., website or web access, Internet connections and computers) for both SCDE faculty and students. The importance of technology training has led to the relatively recent requirement that schools integrate technology training into preservice teacher education (National Council for Accreditation of Teacher Education (NCATE), 1993).

Various external sources (e.g., state legislatures, parent organizations) exert significant pressures on higher education to prepare new teachers to effectively use technology (Ely, 1996). State and local governments hope to increase technology implementation and integration by adding new certification standards and accreditation standards for colleges of education (COEs), in addition to other efforts to reform and upgrade teacher education (Office of Technology Assessment (OTA), 1995). SCDEs realize technology can be a valuable resource for improving teacher training (Harris, 1994; OTA, 1995). Ultimately, higher education institutions must integrate technology seamlessly throughout the curriculum allowing students and faculty to become more efficient and productive. COEs, however, face major challenges in their attempts to build infrastructure, train faculty and staff to integrate technology into their professional life, and model technology integration in daily college classroom instruction (OTA, 1995).

To satisfy this demand, the use of technology must reach a point called critical mass, "the point at which enough individuals have adopted an innovation so that the innovation's further rate of adoption becomes self-sustaining" (Rogers, 1995, p. 313). Educators recognize that contemporary critical mass data can be a powerful planning tool for measuring the success or failure of adoption (Valente, 1993); however, educators lack sufficient critical mass research documenting their adoption of information technologies to aid in implementation planning. Unfortunately, the lack of this information leaves

educational institutions without important information necessary to weigh the advantages and disadvantages of further investments in technology infrastructure.

This research project measured critical mass for the use of interactive information technologies across hundreds of SCDEs. The focus was not on SCDEs individually, but on SCDEs cumulatively. This study fills a void in the literature regarding measurement of critical mass and contingent adoption decisions dependent on access to adequate infrastructure during the adoption of interactive information technologies.

Statement of the Problem

Colleges and universities are embracing information technologies to address the public pressure for reform in the way teachers deliver instruction (DeLoughry, 1996). Through 1994, college administrators had allocated sufficient dollars to connect 63% of all higher education faculty and administrators to campus networks (Green & Gilbert, 1995). During the same period, administrators had established a 6.5 to 1 ratio of students to computers (Green, 1996b) and now expect to see the benefits of these investments (DeLoughry, 1993). Many educational institutions have learned a harsh lesson: simply having technological equipment available for faculty and students does not mean they will use the equipment. To be adopted for use by faculty, technology must be available, pervasive, non-intrusive, easy to use, and reliable (Graves, 1993). Utilization of the technology depends upon access and the faculty and staff receiving appropriate training and guidance in the use of technology.

Technological change is occurring in higher education. Students arrive at universities expecting to use information technologies. College students expect network access for their personal computers. Recent research targeting technology use in higher education (Green, 1996a, 1996b; Green & Eastman, 1994) has focused on the university as a composite of all colleges and content areas. This study suggests that technology use is particularly important to institutions of higher education which prepare future educators. Thus, an important question that SCDE administrators as a whole should address is

whether adequate infrastructure is in place and functioning to help faculty and administration adopt the information technologies necessary to meet the expectations of today's technologically-adept higher education student. According to Rogers (1983, 1995), SCDE faculty and student adoption of information technologies is contingent upon the administration providing the infrastructure necessary to access and use information technologies. Little research exists, however, on contingent adoption decisions.

Computers and information technologies are used as research tools throughout higher education. Denk, Martin and Sarangarm (1993) have shown that computers and information technologies are not becoming an integral part of classroom instruction. The change process often results in avoidance tendencies by faculty, administrators, parents of students, students and even alumni. Strong avoidance tendencies keep many of these potential adopters from adopting, resulting in difficulty reaching a critical mass of users. Understanding critical mass theory allows SCDE educators to understand adoption avoidance tendencies (Bayer & Melone, 1989).

Critical mass theory describes the collective adoption process of interactive media whereby enough individuals adopt an innovation so that the adoption rate is self-sustaining (Markus, 1987). In order to support the adoption, factors must be identified that determine the likelihood of an interactive medium spreading from early adopters to the rest of the community (Markus, 1990). Critical mass theory developed from studies of interactive media such as telephone and electronic mail (Markus, 1987). With these technologies, users' contributions correspond to efforts in reciprocating communication. New interactive media (e.g., World Wide Web (WWW), Bulletin Board Systems (BBS), computer conferencing, the Internet) rely on the users' contribution of information; no medium exists without participants' contributions. Therefore, contribution, when using these technologies, corresponds to efforts in reciprocating information.

As contribution costs increase, the level of contribution to the medium decreases (Markus, 1987). The costs that affect individual contribution are those costs borne by

users. In the case of information technologies, Markus (1987) contends that users bear three types of costs: (a) learning general computer skills and specific communication programs knowledge, (b) developing readiness to reciprocate communication, and (c) gaining access to a computer connected to the Internet.

When potential adopters avoid adopting information technologies because individual costs are too high, it is difficult to achieve critical mass. Accordingly, understanding critical mass resource requirements provides SCDE administrators with a powerful planning tool (Valente, 1993). There is, however, little existing research on individual adoption cost. Two vital questions arise, then, from literature in critical mass: (a) are SCDE faculty or students not adopting information technologies due to individual cost, and (b) at what point have administrators reduced the costs enough to facilitate reaching critical mass for adoption of information technologies?

Purpose of the Study

The adoption of information technologies to assist in the management and delivery of instruction can foster independence and efficiency for both students and faculty. The adoption of these technologies and the parallel movement through the change process, however, requires time and appropriate intervention strategies to be successful. One change model used often in education is the Concerns-Based Adoption Model (CBAM). The CBAM model provides a set of concepts and tools to facilitate the change process (Hall & Hord, 1987). The lack of documentation regarding current use of information technologies and critical mass levels, however, leaves educational institutions without important information necessary to weigh the advantages and disadvantages of investing in information technologies infrastructure. Therefore, this researcher investigated whether SCDEs as a whole have attained critical mass for the use of information technologies and whether attaining critical mass was contingent upon SCDEs providing the necessary information technologies infrastructure.

The integration of student, faculty and administrative choices and decisions makes the adoption process unique in educational settings. The member's decision to adopt is contingent upon SCDE administration supplying the necessary infrastructure and support for the use of technology (Cummings, 1996). Once SCDE faculty adopt, they serve as a role model for students who come to institutions of higher education with technological expectations. This interdependence implies that each group's adoption decision affects when, and if, critical mass will be reached during the adoption cycle. Thus, this study explored the contingent adoption decision of SCDEs at the institutional level in light of the existence of the required infrastructure for the use of information technologies.

According to Markus (1987), the critical mass point for interactive technologies during the diffusion of any innovation occurs when 16% of the potential user population have adopted the innovation. Valente (1995) defines critical mass as a second-order inflection point (where the curve increases most rapidly), occurring early in the adoption process, when about 16% of the individuals have adopted. Finally, Rogers (1995) defines critical mass as the point at which enough individuals have adopted an innovation that the adoption rate becomes self-sustaining. According to Rogers, this usually occurs when 5% to 20% of the potential user population has adopted the innovation. The common thread through Markus', Valente's, and Rogers' definitions of critical mass is the concept of a core user group which is sufficient enough in size to ensure continued adoption of the innovation. The availability of information technologies and the documented increase in the number of users of information technologies indicates core requirements are in place to achieve critical mass (Geoghegan, 1994; Green, 1996b). The physics concept of critical mass is a reminder that key components must combine in order to achieve critical mass. Green (1996b), DeLoughry (1996), and Geoghegan (1994) suggest that higher education is on the brink of reaching critical mass in the use of information technologies.

Summarily, the purposes of this study were threefold. First, this study included investigations of critical mass at the institutional level: (a) whether SCDE institutions had

achieved critical mass for the use of interactive information technologies when measured for each participating SCDE and (b) whether SCDE faculty had achieved critical mass across all participating SCDEs, along with similar investigations for SCDE students and institutional capacity. Second, this study served to advance the knowledge base of diffusion of innovations regarding the effect of contingent innovation-decisions upon critical mass for the use of information technologies across SCDEs. Finally, this study examined the hypothesized contingent innovation-decisions of the SCDE faculty user group and student user group (separately) in light of the existence or nonexistence of the required infrastructure for the use of interactive information technologies.

Statement of the Research Questions

The following research questions were used to guide this study.

1. Has critical mass for combined SCDE faculty and student use of e-mail and web technologies been reached?

2. Has critical mass for SCDE faculty use of e-mail and web technologies been reached?

3. Has critical mass for SCDE student use of e-mail and web technologies been reached?

4. Has critical mass for the required infrastructure for the use of interactive information technologies in SCDEs been reached?

5. Is the number of SCDEs which have reached critical mass for their use of e-mail and web technologies with adequate infrastructure significantly different from the number of SCDEs which have reached critical mass for their use of e-mail and web technologies with inadequate infrastructure?

Statement of the Hypotheses

Research questions one through four were not answered with statistical analyses. Rather, they were judged by comparing arithmetically calculated percentages to the definition of critical mass as stated in this study. Consequently, there are no research hypotheses or parallel null hypotheses for research questions one through four.

The following hypotheses were used to guide this study.

H5a For combined SCDE faculty and students, there will be a significant difference between the frequency of identified combined faculty and student

user institutions identified as having adequate information technologies infrastructure and the frequency of combined faculty and student user institutions identified as not having adequate information technologies infrastructure.

H05a For combined SCDE faculty and students, there will be no significant difference between the frequency of identified combined faculty and student user institutions identified as having adequate information technologies infrastructure and the frequency of combined faculty and student user institutions identified as not having adequate information technologies infrastructure.

H5b For SCDE faculty, there will be a significant difference between the frequency of identified faculty user institutions identified as having adequate information technologies infrastructure and the frequency of identified faculty user institutions identified as not having adequate information technologies infrastructure.

H05b For SCDE faculty, there will be no significant difference between the frequency of identified faculty user institutions identified as having adequate information technologies infrastructure and the frequency of identified faculty user institutions identified as not having adequate information technologies infrastructure.

H5c For SCDE students, there will be a significant difference between the frequency of identified student user institutions identified as having adequate information technologies infrastructure and the frequency of identified student user institutions identified as not having adequate information technologies infrastructure.

H05c For SCDE students, there will be no significant difference between the frequency of identified student user institutions identified as having adequate information technologies infrastructure and the frequency of identified student user institutions identified as not having adequate information technologies infrastructure.

Significance of the Study

A significant quantity of research is available describing innovation diffusion and the change process related to technology. Little research is available on (a) critical mass measures for the use of technological innovations in educational settings, especially at the national level; (b) specific variables that support interactive technologies reaching critical mass; or (c) strategies for diffusion of an innovation during the diffusion process. Rogers (1995) suggests that research in any one of these three areas would further innovation diffusion research.

This study was significant for three reasons. Most importantly, results indicate critical mass for the adoption of interactive information technologies has been achieved in SCDEs. The definitions of critical mass previously stated by Markus (1987), Rogers (1995) and Valente (1995) differ slightly in the exact percentage point at which critical mass occurs, though they agree on the concept of critical mass and its importance to the adoption process. Second, this study examined the relationship between contingent innovation-decisions and critical mass. According to Green and Gilbert (1995), administrators in college and university education departments require data to support decisions they make in the budgeting of billions of dollars for technology in attempts to meet NCATE standards (NCATE, 1993). The adoption of information technologies by SCDE faculty and students is contingent upon funding the necessary infrastructure (Cummings, 1995). Linking the adoption of an innovation and critical mass to a contingent innovation-decision will lay the foundation for further exploration of the adoption process for innovations whose adoption may hinge on contingent decisions. Third, this study examined the contingent adoption decision of SCDE faculty and SCDE students, as separate user groups and as a combined user group, with or without adequate technology infrastructure.

Information technologies currently allow faculty and students to interact and share information outside the traditional classroom setting (Arms, 1992; Norris & MacDonald, 1993). Although the majority of college and university education departments lack adequate faculty technology training programs and staff support (Breivik, 1993; Denk et al., 1993; OTA, 1995), information technologies infrastructure in higher education is reaching critical mass (Green, 1996b). Information about the relationship between faculty and students' decisions regarding the use of information technologies would further the definition of critical mass for interactive technologies and lead to acceleration of SCDEs' adoption of information technologies (Valente, 1995).

The knowledge of minimal infrastructure and implementation requirements provides SCDE administrators a useful tool for planning or revising a budget focused on the

integration of information technologies into classrooms. Understanding information technologies infrastructure requirements, in particular, may be a primary contingent adoption issue for the use of information technologies and, would consequently provide SCDE administrators an additional planning aid. Knowledge of whether SCDEs have reached critical mass is useful to SCDE administrators and faculty as they design interventions and instructional activities for the technological preparation of preservice education students.

Definition of Terms

For purposes of this study, the following definitions will be used.

Concern: The concept of concern is "the composite representation of the feelings, preoccupation, thought, and consideration given to a particular issue or task" (Hall & Hord, 1987, p. 58).

Concerns-Based Adoption Model (CBAM): A model which defines concepts and procedures that provide policy makers, practitioners, and researchers with methods for documenting the change process phenomena, in order that they might take positive action in facilitating change, and to predict effects (Hall, George, & Rutherford, 1986; Hall & Hord, 1987).

Contingent innovation-decision: An individual's decision to adopt or reject an innovation that depends upon some prior innovation-decision (Rogers, 1995).

Critical mass : When the number of users of an innovation reaches or exceeds 16% of the potential user population (Markus, 1987; Valente, 1995).

E-Mail: Electronic mail technologies used for sending and receiving text communications over local or wide-area networks (e.g., CompuServe, America OnLine, Prodigy, or the Internet).

Information technologies: Computers, Internet, e-mail, fax, and World Wide Web (WWW).

Infrastructure: The hardware and software capacity of SCDEs to provide access to e-mail, the WWW, the Internet, and classrooms with technologies available for instruction.

Innovation Configuration Map: Describes the operational forms an innovation can take.

Institutional capacity: A measure of the infrastructure available for SCDE use of information technologies.

Interactive information technologies: E-mail and web technologies.

Internet: A network of connected computer networks that provides access to information and worldwide communications.

SCDEs: Schools, Colleges, and Departments of Education.

Telecommunications technologies: Those information technologies which connect one computer and a modem with another. These technologies can include electronic mail (e-mail), bulletin board systems (BBS), file transfer protocol (ftp), telnet, broadcast video via Internet, audio streaming (radio via Internet), and phone communications over the network.

Universal access: The ability of any member of the community to reach all other members through the medium (Markus, 1987).

World Wide Web: "A graphical environment on computer networks that allows you to access, view, and maintain documents that can include text, data, sound, and video" (Heinich, Molenda, Russell, & Smaldino, 1996).

Limitations of the Study

The limitations of this study were the sample identification, survey instrument and distribution, and knowledge base of survey respondents. The sample was the membership of an intact national organization consisting of private and public four-year schools, colleges, and departments of education. Using this sample placed a limitation on generalizing to higher education outside SCDEs within the U.S. According to Krathwohl (1993), a mailed survey allows for considered rather than spontaneous responses and a

broader geographic sample. The potential for a low response return rate, however, jeopardizes representativeness and generality due to the selective nature of the dropouts.

The survey instrument was created by this researcher. Two CBAM experts examined the survey for face and content validity. The SCDE Technology Survey was sent to member institutions of the national organization as part of a larger survey and submission of the completed survey was completely voluntary.

The survey respondent's knowledge base was the final limitation. The larger surveys were completed by an administrator within the member SCDE. According to Krathwohl (1993), this limitation potentially affects the data analysis in two different ways. First, the administrator may not have known enough about information technologies to respond accurately. For this reason, respondents were provided a telephone number and an e-mail address for questions or clarifications of misconceptions. Secondly, the administrator may have filled out the survey based upon their personal beliefs or perceptions of the SCDE's use of information technologies and not upon actual SCDE use of information technologies. SCDE administrators may have over-estimated the use of information technologies and the institutional infrastructure which supports that use. Additionally, administrators answered on behalf of SCDE students and faculty. These administrators may not have had an accurate perception of faculty and student use of information technology.

Summary

Technology has become so integral to American lives that there is an increased demand for people well trained and highly educated in its use. The reliance in the business world upon technology forecasts a critical path for higher education and, more specifically SCDEs, for the adequate preparation of our youth. SCDEs, however, face major challenges in their attempts to build and maintain infrastructure, train faculty and staff to integrate technology into their professional life, and model technology integration in daily college classroom instruction (OTA, 1995).

To satisfy this demand, the use of technology must reach critical mass (Rogers, 1995). According to a number of researchers (DeLoughry, 1996; Denk et al., 1993; Green, 1996b), institutions of higher education have reached critical mass for information technologies infrastructure. Yet, administrators lack sufficient information about critical mass to adequately evaluate the adoption of information technologies (Valente, 1993) and the impact of infrastructure on contingent innovation-decisions (Rogers, 1995). This void in the critical mass research leaves educational institutions without the information necessary to weigh the advantages and disadvantages of further investments in information technologies infrastructure, technology planning, and technology training for faculty and students.

CHAPTER II

REVIEW OF LITERATURE

Information technology is finally emerging as a permanent, respected, and increasingly essential component of the college experience (Green, 1996b). According to Green (1996a), in the last two years college faculty have doubled their classroom use of information technologies. Green (1996a) attributes this increase to the availability of infrastructure: 70% of higher education institutions currently provide adequate information technologies infrastructure. Unfortunately, Green only provides data for higher education institutions as a whole; not for teacher preparation institutions. This study investigated whether SCDEs have achieved critical mass for the use of interactive information technologies. Second, this study advances the knowledge base of diffusion of innovations regarding the effect of contingent innovation-decisions upon critical mass for the use of information technologies across SCDEs. Finally, this study examined the hypothesized contingent innovation-decision of both SCDE faculty user institutions and students user institutions based on the existence, or non-existence, of adequate infrastructure for the use of interactive information technologies.

This chapter is divided into three main sections. The first section of this literature review focuses on providing a theoretical background for the concept of diffusion of innovations with detail regarding critical mass. In support of this theoretical foundation, this researcher provides an overview of Rogers' diffusion of innovation theory and critical mass, Hall's Concerns-Based Adoption Model (CBAM), and Bandura's social learning theory (SLT). The second section reviews relevant diffusion and change applications from both within education and outside education. The third section provides a review of

documented barriers to reaching critical mass for the use of information technologies in higher education.

Theoretical Framework

Diffusion of Innovation

One reason diffusion theory is so widely accepted is the framework it provides for predicting how fast similar innovations are likely to diffuse (Valente, 1993). Predictions are based on characteristics of the technology, characteristics of the potential technology adopters, networks used to communicate about the technology, and the degree of similarity between the change agents, or opinion leaders, and potential adopters (Bayer & Melone, 1989). Predictors use critical mass as an indicator of successful adoption (Markus, 1990). Unfortunately, many organization adoption studies have investigated only single innovations, such as computers, electronic messaging systems, or teleconferencing (Van de Ven & Rogers, 1988). Although diffusion researchers have explored innovations ranging from hybrid corn to education, higher education lacks diffusion studies exploring critical mass. This study contributes to the diffusion knowledge base by exploring contingent innovation-decisions and critical mass in SCDEs.

This review synthesizes Rogers' diffusion of innovation theory; providing the reader with the foundation for understanding critical mass. Diffusion is the process of communicating about an innovation with and among the population of users and potential users who might choose to adopt or reject it over time (Rogers, 1995; Zaltman, Duncan, & Holbeck, 1973). An innovation is an idea, practice, or object perceived as new by an individual or organization within a social system. In addition, not all innovations are single items. They may be part of interdependent technology clusters (Bayer & Melone, 1989). According to Rogers (1983), the first people adopt an innovation because they can obtain personal benefit(s) from engaging in the innovative activity. The early adopters lay the foundation for reaching critical mass (Rogers, 1995). Identifying critical social factors and processes which influence adoption, implementation, and utilization of a technology,

combined with the knowledge that decision making of individuals, groups and organizations may be predicted and therefore may also be accommodated or redirected through prescriptive strategies (Rogers, 1962, 1983, 1995; Rogers & Shoemaker, 1971) has lead to the application of diffusion theory throughout many disciplines. Diffusion research and the identification of critical human and technical factors can provide SCDE administrators with a foundation to design strategies which address the system characteristics and improvements most valued by SCDE faculty and students.

Diffusion theory is organized around four main elements which are identifiable in every widespread diffusion occurrence: innovation, communication, adoption over time, and social system (Rogers, 1983, 1995). Simply understanding that interactions among these four components are common in the diffusion of an innovation lays a foundation for understanding diffusion theory and its limitations.

Communication

Diffusion requires communication among innovators, diffusers and potential adopters to reach a common understanding of the innovation itself (e.g., what it is, how it works, why it works) and a common understanding of the advantages, disadvantages and consequences of the use of the innovation in a specific situation. Communication is defined as the creation and sharing of information about innovations (Bayer & Melone, 1989). Communication travels through either the mass media channel or interpersonal channel. Mass media channels transmit messages via radio, television, newspaper and the Internet (Rogers, 1995). For this study, mass media channels also include scholarly journals, conventions and national association publications. Interpersonal channels are those involving face-to-face exchange between two or more individuals including peer-to-peer or peer-to-group interactions. Mass media facilitates the gathering of information regarding an innovation by potential users. Interpersonal channels, however, are more effective in persuading an individual to accept a new idea (Rogers, 1995). Campaigns dedicated to achieving rapid diffusion of an innovation should target both interpersonal and mass

communication channels in order to promote rapid and extensive spread of the innovation (Valente, 1995). Communication between and among potential adopters and adopter groups is related to reaching critical mass in the diffusion process (Oliver, Marwell, & Teixeira, 1985). Therefore, SCDE administrators should promote the use of information technologies among faculty and students to facilitate reaching critical mass for the use of interactive information technologies.

Time

The innovation-decision process is a series of decisions through which an individual or organization moves from first learning about the innovation until an adoption decision is confirmed. Occurring over time, the conceptual steps in the innovation-decision process are: (a) knowledge -- exposed to the existence of an innovation and gaining some understanding of how it functions; (b) persuasion -- forming a favorable or unfavorable attitude toward the innovation; (c) decision -- engaging in activities leading to adoption or rejection of the innovation; (d) implementation -- using an innovation; and (e) reinforcement -- seeking reinforcement of an innovation-decision or reversing a previous adoption or rejection decision (Rogers, 1995).

The innovation-decision is characterized by using a normally distributed S-shaped curve plotting potential users against time. The rate of adoption, or the relative speed with which an innovation is adopted, follows an S-shaped curve (Bayer & Melone, 1989; Valente, 1995). The typical S-curve reflects a slow beginning as only a few innovators adopt, followed by a rapid spread throughout the class and finally, a leveling off as near full diffusion is reached. A slowly diffused innovation gives the S-curve a flat shape, while a rapidly diffused innovation makes the S-curve steep. An innovation which is about to reach critical mass will be indicated by a steepening S-curve (Valente, 1995).

Social System

Over the course of time all communication takes place through the social system. Regardless of whether a social system consists of a small group, a large organization or an

entire discipline, the social and communications structure of that system either facilitates or impedes the diffusion of innovations. A social system with higher degrees of interpersonal and informal communication networking wields a greater degree of influence upon an individual to adopt or reject an innovation. Typically, SCDEs represent this highly influential type of communication network. Interpersonal communication channels are especially effective if they link two or more individuals sharing similar beliefs, social status, and education (Rogers, 1995); particularly likely to occur in SCDEs.

Important to the acceptance or rejection of an innovation by a social system and to the rate of adoption by the system are contingent innovation-decisions. Contingent innovation-decisions are choices to adopt or reject an innovation that can be made only after a prior innovation-decision (Rogers, 1983). For example, a faculty member may not be free to adopt the use of a word processor until the SCDE administrator has purchased the necessary hardware and software. The adoption of fax machines provides an illustration of a contingent innovation-decision. Although fax was invented in 1843, it did not reach critical mass until 1987 (Rogers, 1995). The adoption of the fax required phone lines capable of transmitting data at a fast and economical rate, fax machines that companies or individuals could afford, and two or more users who were willing to send or receive a fax (Rogers, 1995). The adoption of fax was contingent on telephone companies providing the required infrastructure, fax machine designers producing cost efficient machines and two or more individuals or companies willing to use, and capable of using, fax technology. The main aspect of contingent decisions is that two (or more) successive decisions are required (Rogers, 1983).

Critical Mass

Defining critical mass. Critical mass theory provides a powerful metaphor and convenient phrase for understanding the size of the adoption audience required for a new technology to be successful (Markus, 1990; Oliver et al., 1985). The critical mass conceptual framework derives its roots from economists, physicists, and sociologists.

Critical mass is a crucial concept for understanding the social nature of the diffusion process (Rogers, 1995). Although based on research from social network scholars, Markus (1987) did additional work that provides the foundation for critical mass in the use of interactive technologies. An interactive technology requires a social group containing two or more members and a vehicle which members control and which enables multidirectional communication (Markus, 1990). Simply stated, each message in a sequence affects the next message. Thus, each user has some control over the timing, content, and sequence of events, allowing others to view the content and perhaps create new communications capabilities (Williams, Rice, & Rogers, 1988). Although critical mass for interactive technologies and noninteractive technologies are similar, the similarity ends when early adopter benefits are considered.

The difference between interactive and noninteractive technology relates to the interdependence effect on early adopters. During the diffusion process for noninteractive innovations, earlier adopters have a sequential interdependence effect on later adopters (Rogers, 1995). Later adopters are influenced by earlier adopters, but not vice versa. For example, early adopters of recycling bore the burden of high costs: monetary costs and time and effort dropping off recycling articles. Later adopters, however, enjoyed lower monetary costs and curbside recycling while the early adopter accrued no additional benefits. With interactive innovations, not only do early adopters have a reciprocal interdependence influence effect on later adopters (Markus, 1987), but later adopters influence early adopters (Markus, 1990). For example, a later adopter who receives a business card with an e-mail address on it requesting information has a few choices for responding. Choosing to send the information via e-mail adds a new adopter to the community and provides benefits for both the new adopter and the early adopter. Relevant to this study, SCDE students who join an established e-mail discussion harvest the same benefits from the discussion as the first adopters and the first adopter's benefits are enhanced by the additional interaction.

This study is an exploration of critical mass for the use of interactive information technologies, specifically e-mail and web technologies. Interactive media are described by two characteristics which are not shared by other innovations. First, widespread usage forces universal access. Second, use of interactive media requires reciprocal interdependence--a single telephone has no benefit for the first adopter. Traditional explanations of the diffusion of innovations process do not accommodate these two properties of interactive media. The interactive information technologies defined in this study (e-mail and web technologies) have gained universal access (Green, 1996b) and require reciprocal interdependence (Rogers, 1995).

Importance of universal access. The following definitions are key to understanding and documenting critical mass in SCDEs. "Universal access is the ability to reach all members through a medium" (Markus, 1987, p. 491). Universal access is important for two reasons. First, if the medium only spread to some members of a group, the community would fracture into users and others. When all people in a community have access to an interactive medium then each member can realize full benefits (Markus, 1990). E-mail communication is more useful for SCDE faculty and students when both have access to the Internet. At a minimum, two users are necessary for either to receive benefits. Second, adopters of a medium saddled with less than universal access who wish to communicate with nonadopters find themselves enjoying less than full benefits from the medium and paying higher costs for these benefits than under universal access conditions (Markus, 1987). Only when a new interactive medium has reached successful adoption levels can the adopters reduce their use and investments of older interactive media (Markus, 1990).

Unfortunately, the same effects that make interactive media universal access advantageous also make it difficult to achieve. The first users to adopt the new interactive medium often experience less than full benefits from the medium and higher costs due to the necessity of maintaining duplicate channels of communication (Markus, 1990). For example, faculty who wish to send assignments over e-mail can send them via e-mail for

adopting students but must also provide assignments via another media (e.g., handouts) for nonadopting students. Therefore, an individual considering adopting an interactive medium is likely to decide not to adopt unless a sizable number of communication partners are already using the medium. This sizable number is called the critical mass of users (Markus, 1990).

Self-sustaining adoption. As stated previously, critical mass occurs at the point in time when enough individuals have adopted an innovation that the innovation's further rate of adoption is self-sustaining (Rogers, 1995). The idea of critical mass originated in physics, where it is defined as the smallest amount of fissionable material that, once triggered, will undergo a spontaneous, sustained chain reaction. The use of the critical mass concept where reciprocal behaviors are started and become self-sustaining can be traced back to sociologists (Oliver et al., 1985). The sociological theory of critical mass seeks to predict the probability, extent, and effectiveness of group action in pursuit of a public good. The research of Oliver and colleagues indicates that once contributions start, they generally accelerate rapidly until the public good is completely provided. Green (1996b) states that the use of information technologies in higher education rose significantly from 1994 to 1995 and had reached critical mass at that time.

Contribution of resources. The primary resource individuals supply to the collective outcome for interactive information technologies is communication discipline; the willingness to reciprocate communication by being accessible for others who may want to reach them (Oliver et al., 1985). For SCDE faculty and students this may simply mean checking their e-mail or the WWW site on a regular basis and responding accordingly. Occasionally, individuals must contribute resources other than discipline in their communication. Faculty or students may have to create their own operational access. The three types of necessary resources for operational access are: infrastructure, access devices, and knowledge about how to use the system (Markus, 1987). In order for faculty to use e-mail, a wired connection to the Internet must be in place along with access to a computer

with e-mail software and some basic knowledge of e-mail use. In the case of many colleges and university settings, the school provides operational access for users. In other cases, access may be the responsibility of a single provider as in a small business or in our homes (Markus, 1990).

Since universal access requires universal participation among community members, achieving universal access depends upon the amount of resources which members must contribute (Markus, 1990). The higher the expense, the less likely that a critical mass of users can be found. Markus (1990) states three propositions related to individual resource contributions that increase the likelihood of a collective outcome:

1. The higher the skill and effort requirements of an interactive medium, the lower the likelihood that universal access will be achieved;
2. The higher the communication discipline requirements of an interactive medium, the lower the likelihood that universal access will be achieved; and
3. The higher the equipment costs borne by early users of an interactive medium, the lower the likelihood that universal access will be achieved. (p. 200)

Accordingly, if SCDE faculty or students are required to provide their own infrastructure (e.g., computers and Internet connection) or invest many hours learning to use information technologies, then universal access has not been achieved and it is unlikely critical mass will be reached. Related to Markus' three propositions is the concept of heterogeneity of interests and resources among members of the community (Oliver et al., 1985). A variety of interests and resources among members of a community will increase the likelihood of universal access (Markus, 1990).

<u>Organizational factors affecting critical mass.</u> The uniqueness of interactive media compared to other innovations is that universal access to interactive media provides a public good that cannot be denied even to people who have not worked to achieve it (Oliver et al., 1985). New students arriving on campus after information technologies have been adopted enjoy the same benefits as the information technology developers. When everyone in a

community uses an interactive medium, the users obtain greater benefits than if only a few members of the community use the interactive medium (Markus, 1990). The innovation process in organizations or communities however, is more complex when compared to the innovation-decision process of individuals (Rogers, 1995). The individual adoption decision may be contingent on the organization supplying the necessary equipment and training. Only after the organization has adopted the innovation does the individual begin to assess how the innovation will impact them, personally and in their jobs (Leonard-Barton, 1988).

According to Rogers (1995, p. 375), "an organization is a stable system of individuals who work together to achieve common goals through a hierarchy of ranks and a division of labor." Rogers also states that individual behavior in an organization is relatively stable and predictable. For example, in educational institutions faculty and administrators work together to provide students with an education. The relationship of the organization and the individual makes diffusion an extensive process. Successful organizational adopters must have strong organizational commitment demonstrated by funding, visibility, support, resolve and knowledge to use the innovation (Kanter, 1988). SCDEs must provide the necessary infrastructure, plans, and support to successfully achieve information technologies adoption (Cummings, 1996).

The individual's innovation response within an organization is influenced by two major forces (Leonard-Barton, 1988). First, individuals of the organization evaluate the innovation's characteristics, similar to an individual adoption. Since the innovation response is made within the context of an organization, however, the characteristics are judged according to the individual's job performance criteria instead of their personal values. Second, how organizations introduce innovations slants innovation responses (Leonard-Barton, 1988). Consequently, organization leadership (SCDE administrators) must understand the innovation's characteristics in relation to the organization's policies

(Attewell, 1992). This study investigates critical mass at the macro-organizational level for SCDEs (institutional use) as opposed to the micro-organizational level (individual use).

Diffusion theory is widely accepted because it provides a framework for estimating the length of time technology takes to be adopted, but many of the studies are based upon a single innovation (Van de Ven & Rogers, 1988). Diffusion of an innovation is complicated by the social diffusion process which involves contingent innovation-decisions, the organization's adoption decision, and the concept of critical mass applied to interactive media. Rogers (1995) challenges future diffusion scholars to move beyond the proven methods and broaden the concepts of the diffusion of innovations. This study explores SCDE contingent innovation-decisions, the existence of adequate information technology infrastructure, and the importance of infrastructure to critical mass.

Concerns-Based Adoption Model (CBAM)

The Concerns-Based Adoption Model provides an established three-tiered model for facilitating the change process. However, for the purposes of this study, only one tier will be discussed: Innovation Configuration Map. The ICM provided this researcher with established procedures for designing a survey to assess the use of information technologies in SCDEs. A brief background on CBAM is provided here to establish the reliability of ICMs.

During the 1969-70 academic year, staff members of the Research and Development Center for Teacher Education at the University of Texas (UT R&D Center) recognized that teachers and professors involved with change were having the same types of concerns about innovations that Fuller (1970) had identified in her studies relevant to teaching. Consequently, a series of studies was conducted throughout the 1970s to test a new change model which included hypothesized categories for innovator adopter concerns (Hall & Loucks, 1978b; Hall & Rutherford, 1976; Hall, Wallace, & Dossett, 1973). Additionally, Rogers and Shoemaker's (1971) and Havelock's (1971) work in change contributed to the development of this new change model. The culmination of the UT R&D

Center efforts resulted in the development of a conceptual model referred to as the Concerns-Based Adoption Model (CBAM).

CBAM makes several assumptions based upon considerable experience derived from involvement in the implementation of innovations in colleges and school settings. These assumptions are essential to CBAM in that they establish the perspective for observing the change process (Hall & Loucks, 1978b):

1. Change is a process, not an event, and it takes time to institute change;
2. Individuals must be the focus if change is to be facilitated and institutions will not change until their members change;
3. The change process is an extremely personal experience and how it is perceived by the individual will strongly influence the outcome;
4. Individuals progress through various stages regarding their emotions and capabilities relating to the innovation;
5. The availability of a client-centered diagnostic/prescriptive model can enhance the individual's facilitation during staff development; and
6. People responsible for the change process must work in an adaptive and systematic way where progress needs to be monitored constantly.

The Concerns-Based Adoption Model addresses each one of these assumptions: the individual's concerns about the innovation, the particular manner in which the innovation is delivered or implemented, and the adaptation of the innovation to the individual.

CBAM includes three diagnostic dimensions: (a) Stages of Concern (SoC), (b) Levels of Use (LoU), and (c) Innovation Configuration Map (ICM). Innovation Configuration Maps are word maps which describe the operational components of an innovation and whether the innovation has been adapted, re-invented, or in some cases mutated (Dirksen & Tharp, 1996; Hall & Loucks, 1978a, 1978b; Heck, Stiegelbauer, Hall, & Loucks, 1981). ICM was the defining construct used in the design of the scenarios which constitute the bulk of the questionnaire items for the survey used in this study.

CBAM is also relevant to this study because of its historical research base in change within educational settings.

Social Learning Theory (SLT)

Social learning theory (SLT) posits that an individual learns by means of observational modeling. Similarly, diffusion theory states that interpersonal networking is the most effective strategy for new adoption. SLT can impact critical mass. During the diffusion process much of the attention is centered on the individual's personal concerns and what can be done to move the individual toward adoptive behaviors. According to Bandura (1977), in order to broaden the understanding of personal determinants, a theory must encompass social and economic factors which provide incentives or disincentives for the adoption of an innovation. In fact, variations in adoption times may occur because later adopters received information via word of mouth while the mass media bombarded early adopters.

Social learning theory distinguishes between two separable processes in the social diffusion of an innovation: acquiring knowledge concerning the innovation and adopting the innovation into practice (Bandura, 1977). Bandura believes acquisition modeling serves as the major medium for transmitting information about new styles of behavior and their effects. According to Rogers (1983), social modeling may occur in interpersonal networks or via mass media channels.

Peer modeling of an innovation affects adoption by socially instructing people in new ways of thinking and behaving as they demonstrate or describe an innovation. According to Bandura (1986), the modeling process is described by four criteria. First, there is a close resemblance of the key features between the modeled pattern and occurrences elsewhere. Second, modeled practices and similar ones appear temporally close together, with the events being modeled preceding in time. Third, diffusion follows a different spatial pattern; similar practices appear in locations where the behavior has been modeled but not where it has never been displayed. Fourth, modeling sparks an

acceleration in similar practices as widespread adoptions create more modeling instigators for further occurrences of the new behavior.

Modeling motivates users as well as informs them. During the change process people are reluctant to undertake a new innovation involving cost and risk. Observation of modeling the benefits and advantages of using a new innovation weakens the potential user's restraint resulting in greater likelihood of adopting the innovation (Bandura, 1986). Unfortunately, negative incentives result in just the opposite.

Implementing information technologies into classroom instruction requires SCDE faculty to learn new technologies and methodologies for their use rather than to modify existing practices. Therefore SCDE administrators must provide faculty with competent models for the use of information technologies to expand. Bandura (1986) suggests using a three-facet approach: modeling, guided enactment, and self-directed application of the acquired skills. Provide faculty and students modeling of the necessary steps broken down into useable pieces. Guide the faculty and students in using the innovation until they feel confident using the innovation and, finally, allow them to practice the guided enactment in scenarios simulating the basics of the real task. Social learning theory, in general, and modeling, in particular, cannot help but directly affect the diffusion of information technologies in SCDEs. This study is an exploration of these effects as a contributor toward the contingent innovation adoption decisions by SCDE faculty and students.

Practical Applications

Partnering teachers and technology could be one of the most effective steps toward systemic educational reform in the United States. Helping teachers incorporate technology within teaching and learning helps students become better users of technology and may also help them become more accomplished learners with contemporary skills required for the information age (OTA, 1995). No one argues that students will not need information technology skills to obtain and maintain gainful employment as large and small companies

increasingly use information technologies for telecommuting, improved problem-solving, and training (Eastmond, 1996).

Unfortunately, many teachers and college faculty lack the necessary tools and skills to integrate technology into classroom instruction (Ely, 1993; LeBaron & Bragg, 1994; OTA, 1995). According to Fullan (1993) and Hall (1992), compounding the problem for K-12 teachers is the implementation of other innovations each year without appropriate consideration for teacher concerns regarding the innovation (e.g., portfolio evaluation, site-based management). Additionally, data from the National Center for Education Statistics (National Center for Education Statistics (NCES), 1996) indicates 50% of U.S. public schools have access to the Internet, a rise of 15% from one year ago, and 74% of those schools without Internet access plan to obtain access. The pressures to adopt new information technology innovations continue to accumulate for classroom teachers who have little time to learn new skills.

These concerns for the future preparation of K-12 students and the current preparation of inservice teachers have shifted the focus of technology training to preservice teacher education. In the 1980s, attention was directed at inservice training of teachers to develop technology integration skills. Teachers were encouraged to "train themselves about the techniques of using technology in the classroom effectively" (Topp, Thompson, & Schmidt, 1993, p. 294). The recent shift in emphasis to preservice teachers is an attempt to accelerate the use of technologies in classroom instruction. According to Carlson (1991) and Topp et al., school districts are demanding incoming teachers who are technology literate. "As preservice teachers leave their teacher preparation programs, they are faced with the realities that school districts demand they use technology, parents expect them to use it, and students want them to use it" (Novak & Berger, 1991, p. 89). The pressure is on SCDE teacher preparation programs to produce a better prepared teaching force; more capable of preparing students with the skills, knowledge, and attitudes necessary for success in the twenty-first century (Parker, 1993).

Education and Technology

NCATE has compiled twelve goals for the educational computing technology preparation of preservice teachers in education programs (NCATE, 1993). The goals include demonstration of computer knowledge and the effective use of computers in classrooms (Gideonse, 1992; Parker, 1993; Rieck, 1992; Warner, 1993; Wetzel, 1993). SCDE teacher preparation institutions face a double-edged sword. They must prepare future teachers for classrooms that will almost certainly require the use of multiple technologies, and, to accomplish this, the higher education faculty must also be skilled in the use and modeling of multiple technologies (Awbrey, 1996; Novak & Berger, 1991; OTA, 1995).

The age-old premise, ‘teachers teach the way they were taught’ should be the foundation for information technologies integration in preservice preparation programs (Bright & Waxman, 1993; Howard & Howard, 1994; Strudler, 1991; White, 1994; Willis, 1992). For teachers who have learned to use technology in their undergraduate years, the evolution to using computers for classroom instruction may be a relatively comfortable one (Willis, 1992).

According to Green (1996a), 90% of all higher education institutions surveyed are connected to the Internet with 76% of the faculty and 60% of the students having access to the Internet. Green’s survey, Campus Computing 1995, focuses on higher education academic computing; the use of computing as well as information technology to support and enhance instruction along with scholarship. For higher education, SCDE teacher preparation programs must model the integration of information technologies within effective instructional practices preparing preservice teachers to increase students’ experiences in rich, informational, computer-mediated environments (Bandura, 1977, 1986, 1993; Barron & Ivers, 1994; Broholm & Aust, 1994; Fullan, 1993; Hannafin & Savenye, 1993; Panyan, McPherson, Steeves, & Hummel, 1994). SCDE teacher education faculty require training in the use and integration of current information technologies if they

are to help preservice teachers incorporate these new technologies as a first step toward strengthening the integration of educational technologies in K-12 schools (Ritchie & Wiburg, 1994).

To facilitate technology integration within education programs and courses, three elements are essential to increasing technology use. First, faculty must have infrastructure, training, equipment, and access (Arms 1992; Awbrey, 1996; Boettcher, 1995; Cummings, 1995; DeLoughry, 1993; Novak & Berger, 1991). For example, a computer on each faculty desk is only one step toward facilitating the use of information technologies. When information technologies have become a necessity to faculty, the next logical step is introducing them into the classroom. However, using information technologies in the classroom requires facilities which accommodate these activities (Topp et al., 1993). Second, ongoing training opportunities must be available to SCDE faculty (Alonzo, 1993; Awbrey, 1996; Cummings, 1996; Hale, 1989; Wetzel, 1992). Unfortunately, the incorrect assumption is made that higher education faculty need little training due to their status in higher education. Finally, faculty members require support and encouragement as they use technology (Alonzo, 1993; Awbrey, 1996; Cummings, 1996; Hale, 1989; Novak & Berger, 1991). Education faculty need reassurance that they can count on support from their administration and peers to overcome the barriers to integration. Additionally, SCDE administrators must include information technology support within their implementation plans.

According to Strudler and Powell (1993), though possessing unprecedented power and potential, technology-based innovations in schools (K-12 and higher education) have failed to achieve successful implementation. Strudler and Powell suggest the following two reasons for slow adoption or failure of educational institutions to adopt information technologies: (a) poor management and preparation for change and (b) failure to recognize impediments to change. For information technology adoption to occur, SCDE

administrators must recognize these two reasons and be prepared to provide the necessary leadership to facilitate change (Fullan, 1991).

Although new technologies may offer significant productivity gains for administrators, new technologies may provide little or no gains for faculty or students. Green (1996a) provides the following example of using information technology on campus but not in the classroom. While e-mail and the World Wide Web (WWW) use is running around 20% of total faculty and student use in higher education, only about 6% of all college courses tap into Web-based resources to support instruction (Green, 1996a). Even though e-mail was not designed for instruction it is appropriate for supplementing learning (Ehrmann, 1996; Poling, 1994). Although information technologies use is not pervasive in the classroom, the presence of information technologies in the learning environment is common: e-mail address on a syllabus, electronic mail as a supplement to office hours, and course assignments that send students to WWW sites in search of information resources (Green, 1996b).

Managing and Preparing for Change

Managing and preparing for change involves coordinating activities and actions which enable educators to consider a variety of ways to use information technologies within classroom instruction. Managing and preparing for change requires that administrators establish a plan for implementing and revising the innovation under adoption. Integration plans might involve developing a plan for computers on faculty desktops, timelines for Internet hookups, development of an education website, seminars and workshops for faculty, encouraging faculty to use information technologies in their professional life and in the classroom, visiting classrooms where the technology is being used or talking with faculty concerning the potential use of information technologies. The preparatory thinking and related actions leading to change (Strudler & Powell, 1993) requires strong leadership commitment to maintain the focus of participants (Guskin, 1996).

Illustrating Guskin's (1996) point, a study conducted by Alonzo (1993), documented a serious lack of direction felt by the faculty during the implementation of technology at Sinclair Community College. According to faculty, the plan lacked validity unless they were involved at all levels during the implementation. Alonzo suggests that SCDE administrators should engage faculty interest and inspire them to aid in planning for technology. Similarly, Geoghegan (1994) states faculty involvement should come from all adopter categories allowing SCDE faculty the opportunity to assimilate information technologies under their own terms and conditions. Additionally all adopter categories must be included to allow for more peer interaction at the social learning level (Bandura, 1986).

Faculty and student adoption of information technologies is contingent on access to quality, reliable, and appropriate hardware and software (Awbrey, 1996; Cummings, 1996). Often nonusers have failed to adopt technology because they lacked access to compatible peripheral equipment or software. Administrators can overcome compatibility problems by establishing a plan that provides for updating or replacing equipment based on an amortized budget or life-cycle funding (Awbrey, 1996; Boettcher, 1995; MacKnight, 1995; McCandless, 1995). Additionally, McCandless (1995) suggests SCDEs prepare a long-range technology budget which includes paying for technology as a periodic operating expense.

Continuing faculty training is another essential focus of information technology implementation planning. According to Boettcher (1995), for an individual's attitude, perception or behavior to change, they must experience new behaviors. Therefore, a hands-on training program which accommodates the learner's needs is necessary for success. Hale (1989) suggests these training programs reflect appropriate curriculum and training materials, a training room with reliable equipment, well prepared trainers, and procedures that assure quality of instruction. Hands-on activities provide education faculty the opportunity to see that using technology not only helps teach what normally could not be

taught without technology, but eventually changes faculty perceptions of what is important to teach (Bandura, 1986; Boettcher, 1995).

The final issue for preparing and managing change is the provision of faculty support (e.g., answering questions, establishing models of classroom use, incentives to adopt information technology) (Awbrey, 1996; Cummings, 1995, 1996). Before faculty adopt, they want to know the personal advantages of using information technologies (Breivik, 1993). Too often, contemporary educational reward systems fail to motivate and reward faculty adopting technology. According to Cummings (1995) and Geoghegan (1994), faculty adopting technology should be rewarded. Possible incentives include: stipend, release time to work on implementing technology, or acknowledging technology implementation similar to acknowledging research for professional evaluation (Shifflet, Richardson, Ghiasvand, Plecque, Verduzco, & Thomas, 1993). Instructional technology support groups are often successful, but require an instructionally and technologically literate staff member (Willis, 1992). The SCDE administrator's commitment to establishing and managing a plan is a clear determinant of whether information technologies are adopted or rejected.

Barriers to Critical Mass

According to Ely (1993), one strategy to initiate change within an educational environment is to create a dissatisfaction with things as they are. One way to stop change in an educational environment is to create a dissatisfaction with things as they are about to become. Awbrey (1996) believes educational institutions lack a coordinated system for the support of technology implementation. Uncoordinated technology implementation creates dissatisfaction leading to rejection or nonuse of the technology early in the adoption process. Therefore, to obtain benefits of information technologies, education institutions must realize that providing infrastructure, faculty development and organizational development are the keys to success. Currently, educators lack adequate equipment, training, and support (Cummings, 1995).

Although e-mail allows faculty and students to communicate outside the classroom, it requires faculty and student effort to facilitate the interactions. For many faculty, using information technologies requires too much time and effort resulting in little gain for their investment (DiSieno, 1995). Faculty who use information technologies must learn to use sophisticated computers, networks and software, while they maintain mastery of the central content and pedagogy of their curriculum. Time is a valuable commodity for higher education faculty and until institutions provide rewards and incentives comparable to the current paradigm which rewards research, faculty will not actively prepare to use information technologies in the classroom (Cummings, 1996).

Finally, implementing change requires time (Fullan, 1993; Hall & Hord, 1987; Rogers, 1995). According to Awbrey (1996), leadership must define appropriate uses of information technologies for proper implementation and evaluation. At the same time, administrators must focus on implementing a plan which facilitates the implementation of information technologies. Ideally, the SCDE plan clearly defines the use of information technologies, provides for equipment, budgets for upgrades, provides for training, and additionally supports faculty learning and using information technologies (Denk et al., 1994; Geoghegan, 1994).

Summary

This chapter included an examination of a broad range of literature regarding the adoption and use of information technologies. This researcher summarized Rogers' diffusion of innovation theory, focusing on critical mass; Hall's CBAM and ICM; and Bandura's social learning theory. These works provide a theoretical framework for the integration of information technologies within SCDEs.

This examination of the literature included implementation strategies and requirements. The influence of the NCATE accreditation standards provides guidance for educational leadership toward facilitating technology integration within preservice teacher

education. Additionally, other research in education, technology, technology integration, and change provide support for the importance of managing change within SCDEs.

Barriers to reaching critical mass documented here provide possible reasons for limited use of information technologies within some educational institutions. This review also documented the lack of technology integration for preservice and inservice teacher education. A critical concern is that although preservice teacher education lacks technology integration, SCDEs bear the responsibility for providing instruction for preservice teachers which facilitates the integration of information technologies within their future classrooms and professional lives.

CHAPTER III

DESIGN AND METHODOLOGY

Introduction

The purposes of this study were threefold. First, this study included investigations of critical mass at the institutional level: (a) whether SCDE institutions had achieved critical mass for the use of interactive information technologies when measured for each participating SCDE and (b) whether SCDE faculty had achieved critical mass across all participating SCDEs, along with similar investigations for SCDE students and institutional capacity. Second, this study served to advance the knowledge base of diffusion of innovations regarding the effect of contingent innovation-decisions upon critical mass for the use of information technologies across SCDEs. Finally, this study examined the hypothesized contingent innovation-decisions of the SCDE faculty user group and student user group (separately) in light of the existence or nonexistence of the required infrastructure for the use of interactive information technologies.

This chapter contains a description of the design and methodology used in this research. First, the research design is described; then, the participants, instrumentation, and procedures are described. The research questions from Chapter I are restated along with their corresponding hypotheses.

Research Design

Measuring the use of information technologies within Schools, Departments, and Colleges of Education (SCDEs) was the major focus of this study. Data was also collected on the existing infrastructure for information technologies within SCDEs which either supports faculty and student use or creates a barrier for use. Data was collected using a one

page (front and back) survey instrument that was an addendum to the Joint Data Collection System (JDCS) sent to all members of the American Association of Colleges for Teacher Education (AACTE). The necessary approval to conduct the study was obtained from AACTE and the Internal Review Board of the University of Northern Colorado. While there are many methods for the collection of descriptive data, a survey is an appropriate method for assessing perceptual information directly from a sample population (LeCompte & Goetz, 1982).

The SCDE Technology Survey design was based upon the concept of Innovation Configuration Maps from Hall and Hord's (1987) Concerns-Based Adoption Model. Most items on the SCDE Technology Survey (see Appendix A) were created with four scenario options available. Response options ranged from scenarios describing highly integrated use of information technologies to an option of "Unknown." The items created for the SCDE Technology Survey also considered the research of Green and Eastman (1994), Green (1996a), and the OTA (1995). The survey consisted of three sections to collect data on the use of information technologies: (a) student use, (b) faculty use, and (c) institutional capacity. Not all data gathered were used in this study. The additional data collected will be available in report form (Persichitte, Tharp, & Caffarella, in press).

Surveys were distributed during the summer of 1996 by AACTE and member institutions were allowed 60 days to respond. All completed SCDE Technology Surveys and AACTE demographic data were forwarded to this researcher in December. The data were analyzed for SCDEs as a composite of the faculty user group, student user group and infrastructure. Data were reanalyzed for these categories independently.

Participants

The participants in this study were member institutions of AACTE. AACTE is a national, voluntary association of colleges and universities with undergraduate or graduate programs which prepare professional educators. The Association supports programs in data gathering, equity, leadership development, networking, policy analysis, professional

issues, and scholarship. The Association's more than 700 member institutions include private, state, and municipal colleges and universities -- both large and small -- located in every state, the District of Columbia, the Virgin Islands, Puerto Rico, and Guam.

Description of the Instrument

This researcher collected data with a questionnaire that consisted of three sections: Student Use, Faculty Use, and Institutional Capacity (see Appendix A). The questionnaire was created to supplement AACTE's Joint Data Collection System (JDCS) that is distributed annually. AACTE's parameters for the design of the questionnaire were: one page front and back; questions related to technology use in SCDEs; and address concerns raised by the OTA report (1995) relevant to preservice education and technology use.

For coding purposes, the scenarios were labeled A, B, C, D sequentially from left to right. Scenarios A and B are descriptions of the use of information technologies. Scenario C is a description of information technologies nonuse. Scenario D is the option for unknown or missing information. Additionally, the institutional capacity section included a few open response questions which gathered data about SCDE technology plans, availability of computers, Internet connections and student computer labs.

Design of the Questionnaire

The questionnaire was designed to augment recent research reports from Green (1996a), Green and Eastman (1994), ISTE (1992), NCATE (1993), and OTA (1995). The foundational concepts for the survey come from Green and Eastman's (1994) 1993 Campus Computing survey and Green's (1996a) 1995 Campus Computing survey. The annual Campus Computing surveys (which began in 1990) most accurately reflect technology integration in higher education (DeLoughry, 1996). Green and Eastman's 1993 research provides a historical map of technology integration in higher education at the beginning of the web and Internet revolution (Geoghegan, 1994). Green's Campus Computing reports provide information for higher education across all disciplines but they do not provide data specifically for SCDEs.

The SCDE Technology Survey was evaluated for face validity and content validity by two CBAM experts. Prior to distribution, the survey was reviewed by the AACTE Research Committee. The committee suggested minor changes to improve the page layout and to fit AACTE printing requirements. A significant addition to the instrument was the inclusion of the open response questions in the institutional capacity section for gathering data on hardware, planning for technology, and Internet connections.

Data Collection Procedures

The SCDE Technology Survey was distributed as an addendum to AACTE's eight page (front and back) survey, the 1996 Joint Data Collection System (JDCS). The JDCS, distributed with the support of NCATE, provides AACTE with significant data about member institutions and creates an authoritative, aggregate database for research associated with teacher preparation. The 1996 JDCS was sent to 744 SCDE institutions. The information collected from member SCDEs includes basic institutional information (e.g., program type, level, affiliation), enrollment data, productivity data, faculty data, and resource data. This demographic information was reported when it supported this research project.

Member SCDEs received their mailed surveys in August. While mailed surveys often suffer a low response rate, the 1995 JDCS return rate was 77% and the 1996 return was 465 out of 744 SCDE institutions (63%). The JDCS is typically completed by SCDE administrators (e.g., deans, associate deans, chairpersons). Surveys were to be returned to AACTE headquarters by October first.

Data Analysis Procedures

For purposes of this study, scenarios A and B from the questionnaire were assigned a value of one representing use of information technologies (items 2, 4, 5, 6, 7, 8, 9, 10, 11, and 12). For the same items, scenario C was assigned a value of zero representing nonuse. Scenario D was coded as missing data except for items 11 and 12 which indicated a lack of infrastructure. Scenario D for items 11 and 12 was coded zero.

Scenarios A and B were assigned a value of one representing the existence of infrastructure for information technologies for items 15, 17, and 18. For these items, scenario C was assigned a value of zero representing lack of infrastructure and scenario D was coded as missing data.

The data collected in this study were used to produce an information technologies profile for each SCDE. The SCDE's profiles were cumulatively reanalyzed by faculty use, student use, and infrastructure for information technologies. Faculty use of information technologies was measured using items 8, 9, 10, 11, and 12. Student use of information technologies was measured using items 2, 4, 5, 6, and 7. Institutional capacity (infrastructure) was measured using items 14, 15, 17, 18, and 21. A summary of additional data collected with the SCDE Technology Survey will be available through AACTE (Persichitte et al., in press).

The percentage value given in response to item 21 was coded as one, representing the existence of infrastructure, if the reported value was greater than or equal to 60%. For reported values less than 60%, item 21 was coded as zero, representing lack of infrastructure.

The cut-off score for each group to be identified as a user/nonuser (greater than or equal to three) was based on data reported in Green's (1996a) research of two-year and four-year higher education institutions. Using Green's cut-off, users were identified as those institutions with a percentage greater than or equal to 60; nonusers were those institutions with a percentage less than 60. Green's data reveals 60% of undergraduate students have access to the Internet. Since primary focus of this study was SCDEs, this researcher established 60% as the baseline for all three groups.

To complete calculations for the measurement of critical mass across SCDEs, this researcher first identified faculty users and student users at each institution and whether each institution was a user/nonuser of interactive information technologies. First, faculty use was determined by summing the coded values (one, zero, missing) for the faculty

group items previously defined. If the total faculty use score was greater than or equal to three (maximum score was five), then the institution was identified as a faculty user institution. Second, student use was determined by summing the coded values for the student group items previously defined. If the total student use score was greater than or equal to three (maximum score was five), then the institution was identified as a student user institution. Third, adequate institutional capacity (infrastructure) was determined by summing the coded values for the infrastructure group items previously defined. If the total infrastructure score was greater than or equal to three (maximum score was five), then the institution was identified as an adequate infrastructure provider institution. Fourth, an institutional user score was determined by recoding the group results as follows: faculty use coded as one; faculty nonuse coded as zero; student use coded as one; student nonuse coded as zero. The institutional user score was determined by summing the recoded group values. If the total institutional user score was equal to two (maximum score was two), then the institution was identified as an institutional user. Fifth, SCDE critical mass was determined by tallying the number of institutional users and dividing this total by the total number of reporting institutions resulting in a percentage of SCDE user institutions. Critical mass for SCDEs was reached if the SCDE percentage was greater than or equal to 16% (Markus, 1987; Valente 1995).

Chi-square tests of independence were employed to determine whether there was a difference between the frequency of user/nonuser groups for both faculty and students when adequate infrastructure for information technologies was available. Chi-square tests of independence were also employed to determine if SCDEs had reached critical mass for the use of information technologies when adequate infrastructure was not available.

Statement of the Research Questions

The research questions for this study were:

1. Has critical mass for combined SCDE faculty and student use of e-mail and web technologies been reached?

2. Has critical mass for SCDE faculty use of e-mail and web technologies been reached?

3. Has critical mass for SCDE student use of e-mail and web technologies been reached?

4. Has critical mass for the required infrastructure for the use of interactive information technologies in SCDEs been reached?

5. Is the number of SCDEs which have reached critical mass for their use of e-mail and web technologies with adequate infrastructure significantly different from the number of SCDEs which have reached critical mass for their use of e-mail and web technologies with inadequate infrastructure?

Statistical Analysis

The alpha level selected for all statistical tests was .05. Since the probability of Type I error can be controlled through the alpha level, this researcher considered that increasing the alpha level reduced the probability of Type I error but also increased the probability of Type II error. Increasing sample size could have reduced the probability of a Type II error. Since the sample size for this study was relatively large (465), the confidence interval for an alpha level of .01 or .05 varied little (Glass & Hopkins, 1984). Analyses of the survey data included descriptive measures and, when appropriate, followed established procedures for the use of Chi-square tests of independence (Glass & Hopkins, 1984; Krathwohl, 1993; Marascuilo & McSweeney, 1977).

Research questions one through four and corresponding analyses were:

RQ1 Has critical mass for combined SCDE faculty and student use of e-mail and web technologies been reached?

Analysis: The analysis was performed on SCDE Technology Survey data collected from student use questionnaire items 2, 4, 5, 6, and 7, and faculty use questionnaire items 8, 9, 10, 11, and 12. A total student use score greater than or equal to three and total faculty use score greater than or equal to three identified the institution as a combined faculty and student user institution. An observed critical mass value was calculated as the ratio of the number of institutions identified as combined faculty and student user

institutions and the number of reporting institutions. Critical mass for the use of information technologies was reached when the percentage was greater than or equal to 16% (Markus, 1987; Valente, 1995).

RQ2 Has critical mass for SCDE faculty use of e-mail and web technologies been reached?

Analysis: The analysis was performed on SCDE Technology Survey data collected from faculty use questionnaire items 8, 9, 10, 11, and 12. A total faculty use score greater than or equal to three identified the institution as a faculty user institution. An observed critical mass value was calculated as the ratio of the number of institutions identified as faculty user institutions and the number of reporting institutions. Critical mass for the use of information technologies was reached when the percentage was greater than or equal to 16% (Markus, 1987; Valente, 1995).

RQ3 Has critical mass for SCDE student use of e-mail and web technologies been reached?

Analysis: The analysis was performed on SCDE Technology Survey data collected from student use questionnaire items 2, 4, 5, 6, and 7. A total student use score greater than or equal to three identified the institution as a student user institution. An observed critical mass value was calculated as the ratio of the number of institutions identified as student user institutions and the number of reporting institutions. Critical mass for the use of information technologies was reached when the percentage was greater than or equal to 16% (Markus, 1987; Valente, 1995).

RQ4 Has critical mass for the required infrastructure for the use of interactive information technologies in SCDEs been reached?

Analysis: The analysis was performed on SCDE Technology Survey data collected from institutional capacity questionnaire items 14, 15, 17, 18, and 21. A

total institutional capacity score greater than or equal to three identified the institution as an infrastructure provider institution. An observed critical mass value was calculated as the ratio of the number of institutions identified as infrastructure provider institutions and the number of reporting institutions. Critical mass for the provision of required infrastructure for the use of information technologies was reached when the percentage was greater than or equal to 16% (Markus, 1987; Valente, 1995).

Null hypotheses and the corresponding statistical procedures were:

$H_{0}5a$ For combined SCDE faculty and students, there will be no significant difference between the frequency of identified combined faculty and student user institutions identified as having adequate information technologies infrastructure and the frequency of combined faculty and student user institutions identified as not having adequate information technologies infrastructure.

Statistic: Chi-square test of independence.

$H_{0}5b$ For SCDE faculty, there will be no significant difference between the frequency of identified faculty user institutions identified as having adequate information technologies infrastructure and the frequency of identified faculty user institutions identified as not having adequate information technologies infrastructure.

Statistic: Chi-square test of independence.

$H_{0}5c$ For SCDE students, there will be no significant difference between the frequency of identified student user institutions identified as having adequate information technologies infrastructure and the frequency of identified student user institutions identified as not having adequate information technologies infrastructure.

Statistic: Chi-square test of independence.

Summary

The primary purpose of this study was to document whether critical mass had been reached for SCDE use of interactive information technologies at the institutional level. Additionally, this study examined the hypothesized contingent innovation-decision of the SCDE faculty user group and student user group (separately) in light of the existence or

nonexistence of the required infrastructure for the use of interactive information technologies. This chapter contained a description of the methods and procedures that were employed in the collection and analysis of the data. Data was collected with a survey which was created by this researcher and distributed as part of AACTE's annual JDCS. The research instrument was described as were data coding and analysis procedures.

CHAPTER IV

RESULTS

Introduction

The research conducted in this study was an investigation of critical mass for the use of interactive information technologies across SCDEs. The variables explored were: student use, faculty use, combined student and faculty use, and technology infrastructure. Data were collected with the SCDE Technology Survey (see Appendix A).

Data Analysis

The SCDE Technology Survey was distributed to 744 SCDE institutions as an addendum to AACTE's 1996 Joint Data Collection System (JDCS). SCDE administrators completed the Technology Survey and forwarded them to AACTE headquarters as part of the JDCS. AACTE forwarded all returned Technology Surveys to this researcher on January 1, 1997. A total of 465 completed surveys were received from the United States, Guam, and Puerto Rico. The completed SCDE Technology Surveys represented a 63% return rate. All 465 surveys (100%) were usable with 351 indicating NCATE membership.

Analysis of Research Questions

This section is divided into a discussion of the data collected and the statistical procedures and analyses applied for each research question. The research questions are restated and corresponding hypotheses are presented, followed by an explanation of the data, a summary of the analysis and findings, and a statement indicating the rejection, or retention, of the null hypotheses. Tables are presented which display the statistical data and the level of significance when appropriate.

Analysis of Critical Mass

RQ1 Has critical mass for combined SCDE faculty and student use of e-mail and web technologies been reached?

This research question was measured by tallying the number of institutions identified as having combined SCDE faculty and student users, then calculating the representative percentage based on the number of reporting institutions. Critical mass has been reached when the number of users of an innovation reaches or exceeds 16% of the potential user population (Markus, 1987; Valente, 1995). In this study, the potential user population was the 465 respondent SCDEs. Critical mass for combined SCDE faculty and student users of information technologies was reached when the number of combined SCDE faculty and student users divided by 465 resulted in a percentage greater than or equal to 16%. The results of these calculations for critical mass of combined SCDE faculty and student users are displayed in Table 1.

Table 1

Results of the JDCS Questionnaire Data Analysis for Combined SCDE Faculty and Student User Institutions

Variable	N	Users	Percent	Critical Mass
Faculty-Student	465	405	87%*	>16%

* indicates critical mass has been reached

Combined SCDE faculty and student user institutions were identified by recoding the group results as follows: faculty use coded as one; faculty nonuse coded as zero; student use coded as one; student nonuse coded as zero. The institutional user score was determined by summing the recoded group values. If the total institutional user score was equal to two (maximum score was two), then the institution was identified as a combined SCDE faculty and student user institution.

The JDCS data collected from questionnaire items 2, 4, 5, 6, 7, 8, 9, 10, 11, and 12 resulted in a combined SCDE faculty and student user value of 405 out of 465 reporting institutions, producing a critical mass value of 87%. Since the observed critical mass score for combined faculty and student users is greater than the defined value of critical mass (16%), critical mass for the use of e-mail and web technologies by SCDE institutions has been reached.

RQ2 Has critical mass for SCDE faculty use of e-mail and web technologies been reached?

This research question was measured by tallying the number of institutions identified as SCDE faculty users and then calculating the representative percentage based on the number of reporting institutions. Critical mass for SCDE faculty users of information technologies was reached when the number of SCDE faculty users divided by 465 resulted in a percentage greater than or equal to 16%. The results of these calculations for critical mass of SCDE faculty user at the institutional level are displayed in Table 2.

Table 2

Results of the JDCS Questionnaire Data Analysis for SCDE Faculty User Institutions

Variable	N	Users	Percent	Critical Mass
Faculty	465	429	92%*	>16%

* indicates critical mass has been reached

The JDCS data collected from questionnaire items 8, 9, 10, 11, and 12 resulted in a SCDE faculty user value of 429 out of 465 reporting institutions, producing a critical mass value of 92%. Since the observed critical mass value for SCDE faculty users is greater than the defined value of critical mass (16%), critical mass for SCDE institutional use of e-mail and web technologies has been reached.

RQ3 Has critical mass for SCDE student use of e-mail and web technologies been reached?

This research question was measured by tallying the number of institutions identified as SCDE student user institutions and then calculating the representative percentage based on the number of reporting institutions. Critical mass for SCDE student user of information technologies was reached when the number of SCDE student user institutions divided by 465 resulted in a percentage greater than or equal to 16%. The results of these calculations for critical mass for SCDE student user at the institutional level are displayed in Table 3.

Table 3

Results of the JDCS Questionnaire Data Analysis for SCDE Student User Institutions

Variable	N	Users	Percent	Critical Mass
Student	465	420	90%*	>16%

* indicates critical mass has been reached

The JDCS data collected from questionnaire items 2, 4, 5, 6, and 7 resulted in a SCDE student user value of 420 out of 465 reporting institutions, producing a critical mass value of 90%. Since the observed critical mass value for SCDE student user at the institutional level is greater than the defined value of critical mass (16%), critical mass for SCDE institutional use of e-mail and web technologies has been reached.

RQ4 Has critical mass for the required infrastructure for the use of interactive information technologies in SCDEs been reached?

This research question was measured by tallying the number of institutions identified as SCDE infrastructure provider institutions and then calculating the representative percentage based on the number of reporting institutions. Critical mass for SCDE infrastructure provider institutions of information technologies was reached when the number of SCDE infrastructure provider institutions divided by 465 resulted in a percentage greater than or equal to 16%. The results of these calculations for critical mass for SCDE infrastructure provider institutions are displayed in Table 4.

Table 4

Results of the JDCS Questionnaire Data Analysis for SCDE Infrastructure Provider Institutions

Variable	N	Users	Percent	Critical Mass
Infrastructure	465	444	95%*	>16%

* indicates critical mass has been reached

The JDCS data collected from questionnaire items 14, 15, 17, 18, and 21 resulted in a SCDE infrastructure provider institution value of 444 out of 465 reporting institutions, producing a critical mass value of 95%. Since the observed critical mass value for SCDE infrastructure provider institutions is greater than the defined value of critical mass (16%), critical mass for the existence of adequate infrastructure at SCDE institutions has been reached.

Summarized in Table 5 are the analyses of the four critical mass research questions. The achievement of critical mass for all four variables under consideration (combined student and faculty use, faculty use, student use, and technology infrastructure) indicates critical mass has been achieved in SCDE institutions for the use of e-mail and web technologies.

Table 5

Summary of Critical Mass Calculations and Analyses

Variable	N	Users	Percent	Critical Mass
Faculty-Student	465	405	87%*	>16%
Faculty	465	429	92%*	>16%
Student	465	420	90%*	>16%
Infrastructure	465	444	95%*	>16%

* indicates critical mass has been reached

Test of Hypotheses

RQ5 Is the number of SCDEs which have reached critical mass for their use of e-mail and web technologies with adequate infrastructure significantly different from the number of SCDEs which have reached critical mass for their use of e-mail and web technologies with inadequate infrastructure?

H05a For combined SCDE faculty and students, there will be no significant difference between the frequency of identified combined faculty and student user institutions identified as having adequate information technologies infrastructure and the frequency of combined faculty and student user institutions identified as not having adequate information technologies infrastructure.

A Chi-square test of independence was conducted for this hypothesis comparing user and nonuser groups for combined SCDE faculty and students to the provision of adequate infrastructure for the use of information technologies. The purpose was to determine if the proportions of users and nonusers were significantly different for SCDEs with adequate infrastructure compared to SCDEs with inadequate infrastructure. The resulting Chi-square statistic of 14.672 was found to be significant. The Chi-square results indicate that 406 out of 455 (89%) combined faculty and student user institutions identified as having adequate infrastructure was significant when compared to the 5 out of 10 (50%) combined faculty and student user institutions identified as lacking adequate infrastructure. In this sample, combined SCDE faculty and student use was significantly greater for institutions which provide adequate e-mail and web technologies infrastructure. The Chi-square test of independence scores for the combined SCDE faculty and student users and nonusers compared to institutional infrastructure are displayed in Table 6.

H05b For SCDE faculty, there will be no significant difference between the frequency of identified faculty user institutions identified as having adequate information technologies infrastructure and the frequency of identified faculty user institutions identified as not having adequate information technologies infrastructure.

A Chi-square test of independence was conducted for this hypothesis comparing user and nonuser faculty groups to adequate institutional infrastructure for information technologies. The purpose was to determine if the proportions of faculty users and faculty nonusers were significantly different for institutions with adequate infrastructure and for

institutions with inadequate infrastructure. The resulting Chi-square statistic of 34.929 was found to be significant. The Chi-square results indicate that 432 out of 455 (95%) faculty user institutions identified as having adequate infrastructure was significant when compared to the 5 out of 10 (50%) faculty user institutions identified as lacking adequate infrastructure. In this sample, faculty use was significantly greater for institutions which provided adequate e-mail and web technologies infrastructure. The Chi-square test of independence scores for the faculty users and nonusers compared to institutional infrastructure are displayed in Table 7.

Table 6

Results of the Chi-square for Combined Faculty and Student Nonusers and Users for Institutions with Adequate and Inadequate Infrastructure

		Nonuser	User	N	Chi-sq	PR > Chi-sq
	No	5	5	10	14.672*	<.001
Infrastructure						
	Yes	49	406	455		

alpha = .05, DF = 1
significance indicated by *

H05c For SCDE students, there will be no significant difference between the frequency of identified student user institutions identified as having adequate information technologies infrastructure and the frequency of identified student user institutions identified as not having adequate information technologies infrastructure.

A Chi-square test of independence was conducted for this hypothesis comparing user and nonuser groups for students to the availability of adequate institutional infrastructure for information technologies. The purpose was to determine if the proportions of student users and student nonusers were significantly different for institutions with adequate infrastructure and for institutions with inadequate infrastructure.

Table 7

Results of the Chi-square for Faculty Nonusers and Users for Institutions with Adequate and Inadequate Infrastructure

		Nonuser	User	N	Chi-sq	PR > Chi-sq
	No	5	5	10	34.929*	<.001
Infrastructure						
	Yes	23	432	455		

alpha = .05, DF = 1
significance indicated by *

The resulting Chi-square statistic of .04551 was not found to be significant. The Chi-square results indicate that 418 out of 455 (92%) student user institutions identified as having adequate infrastructure was not significant when compared to the 9 out of 10 (90%) student user institutions identified as lacking adequate infrastructure. Consequently, the null hypothesis was retained. For this sample, student use was not significantly greater for institutions which provided adequate e-mail and web technologies infrastructure. The Chi-square test of independence scores for the student users and nonusers compared to institutional infrastructure are displayed in Table 8.

Table 8

Results of the Chi-square for Student Nonusers and Users for Institutions with Adequate and Inadequate Infrastructure

		Nonuser	User	N	Chi-sq	PR > Chi-sq
	No	1	9	10	.04551	>.831
Infrastructure						
	Yes	37	418	455		

alpha = .05, DF = 1

Summary

The data in this study were analyzed by comparing calculated critical mass percentages to the percentage definition of critical mass or by utilizing the Chi-square test of independence. The user group percentage calculations were used to determine whether critical mass at the institutional level had been achieved for combined SCDE faculty and student use, SCDE faculty use, SCDE student use, and adequate SCDE infrastructure for the use of e-mail and web technologies. These comparisons indicated critical mass for the use of e-mail and web technologies has been reached for SCDEs in all four variable categories.

The Chi-square test of independence was used to determine if there was a significant difference in the number of institutions with identified user groups (combined SCDE faculty and student, SCDE faculty, and SCDE students) and their use of e-mail and web technologies when adequate infrastructure was available in comparison to when adequate infrastructure was not available. For the combined SCDE faculty and student user group and for the SCDE faculty user group, a significantly greater proportion of users were found at institutions which provided adequate infrastructure for the use of e-mail and web technologies. The proportion of SCDE student user groups for institutions with adequate infrastructure was not statistically different from the SCDE student user groups for institutions without adequate infrastructure.

CHAPTER V

DISCUSSION

Introduction

Information technologies are increasingly common in homes, schools, and offices (Green, 1997). Consequently, higher education institutions are increasingly confronted with rising expectations from students across all disciplines and in all types of educational institutions. These expectations include the anticipated use of interactive information technologies as part of their learning and instructional experiences. Interactive information technologies were defined as e-mail and web technologies for this study. Results of this study indicate that critical mass for the use of information technologies in SCDEs has been achieved. Additionally, according to Green (1997), there is substantial evidence within higher education environments which confirms that the existence of information technologies infrastructure fosters innovation among faculty and students. Consequently, an educator's decision to adopt information technologies takes on critical importance when it is contingent upon SCDEs supplying the necessary equipment, training and support which allows faculty the opportunity to implement information technologies in the classroom setting (Awbrey, 1996; Cummings, 1996). This study focused on the documentation of critical mass for the use of information technologies across SCDEs and on the contingent adoption of information technologies dependent upon infrastructure availability.

This chapter contains a brief review of the purpose, research questions and hypotheses, and methodology for this research. The findings of this study are summarized in the discussion section and discussed relative to the research questions and relevant

literature. Additionally, based on the analysis of collected data, recommendations and suggestions for further research are presented.

Purpose of the Study

The purposes of this study were threefold. First, this study included investigations of critical mass at the institutional level: (a) whether SCDE institutions had achieved critical mass for the use of interactive information technologies when measured for each participating SCDE and (b) whether SCDE faculty had achieved critical mass across all participating SCDEs, along with similar investigations for SCDE students and institutional capacity. Second, this study served to advance the knowledge base of diffusion of innovations regarding the effect of contingent innovation-decisions upon critical mass for the use of information technologies across SCDEs. Finally, this study examined the hypothesized contingent innovation-decisions of the SCDE faculty user group and student user group (separately) in light of the existence or nonexistence of the required infrastructure for the use of interactive information technologies.

Research Questions and Hypotheses

This study addressed the following research questions based on literature and research related to critical mass (Markus, 1987; Rogers, 1995; Valente, 1995) and contingent innovation-decisions (Rogers, 1995) for interactive information technologies use within SCDEs. The corresponding research hypotheses are presented immediately following the appropriate research questions.

RQ1 Has critical mass for combined SCDE faculty and student use of e-mail and web technologies been reached?

RQ2 Has critical mass for SCDE faculty use of e-mail and web technologies been reached?

RQ3 Has critical mass for SCDE student use of e-mail and web technologies been reached?

RQ4 Has critical mass for the required infrastructure for the use of interactive information technologies in SCDEs been reached?

RQ5 Is the number of SCDEs which have reached critical mass for their use of e-mail and web technologies with adequate infrastructure significantly different from the number of SCDEs which have reached critical mass for their use of e-mail and web technologies with inadequate infrastructure?

H5a For combined SCDE faculty and students, there will be a significant difference between the frequency of identified combined faculty and student user institutions identified as having adequate information technologies infrastructure and the frequency of combined faculty and student user institutions identified as not having adequate information technologies infrastructure.

H5b For SCDE faculty, there will be a significant difference between the frequency of identified faculty user institutions identified as having adequate information technologies infrastructure and the frequency of identified faculty user institutions identified as not having adequate information technologies infrastructure.

H5c For SCDE students, there will be a significant difference between the frequency of identified student user institutions identified as having adequate information technologies infrastructure and the frequency of identified student user institutions identified as not having adequate information technologies infrastructure.

Methodology

AACTE distributed the JDCS and SCDE Technology Survey to 744 member SCDEs. This researcher developed the questionnaire to address the research questions and hypotheses of this study. The JDCS Technology Survey was used to collect data related to student use, faculty use, and institutional capacity for information technologies across SCDEs. Research data were collected from 465 SCDEs.

The research data were analyzed using several analytical procedures to answer the research questions. Analysis of research questions one through four indicate that critical mass has been achieved for combined SCDE faculty and student user institutions, SCDE faculty user institutions, SCDE student user institutions, and the provision of adequate infrastructure by SCDEs. Only one of the three null hypotheses associated with research question five was found to be tenable; two were found untenable based on the results of the calculations comparing user institutions to the defined level of critical mass (16%) and Chi-square tests of independence. The results of all analyses are discussed in greater detail within the next section.

Discussion

The first research question was concerned with whether critical mass at the institutional level had been achieved for the use of interactive information technologies across SCDEs. Critical mass, as defined in this study, had been reached when the number of users of an innovation reached or exceeded 16% of the potential user population (Markus, 1987; Valente, 1995). Previous research reported that combined faculty and student use of information technologies within institutions of higher education had achieved critical mass (Green, 1996a; 1997). This study confirmed these findings for SCDEs. The observed critical mass at the institutional level for combined SCDE faculty and students was 87%.

The second research question of this study pertained to critical mass at the institutional level for the use of e-mail and web technologies by SCDE faculty. Green's (1996a; 1997) research reported that faculty use of information technologies had achieved critical mass for faculty in institutions of higher education. This study confirmed these findings for SCDEs. This study documented a critical mass value at the institutional level of 92% for faculty use of information technologies across SCDEs.

The third research question of this study was related to critical mass at the institutional level for the use of e-mail and web technologies by SCDE students. Previous research indicated that student use of information technologies had achieved critical mass within institutions of higher education (Green, 1996a; 1997). Results of this study confirmed these findings for SCDEs. The critical mass at the institutional level value for SCDE student use was found to be 90% across SCDEs.

The fourth question of this study was concerned with critical mass at the institutional level for the required infrastructure necessary for the use of interactive information technologies in SCDEs. Green's (1996a; 1997) previous research reported that institutions of higher education had achieved critical mass at the institutional level for required infrastructure for the use of information technologies. Results of the critical mass

calculations confirm these results for SCDEs. This study found that 95% of the reporting SCDEs have adequate infrastructure for the use of interactive information technologies.

The fifth research question and related hypotheses were concerned with whether SCDEs had reached critical mass at the institutional level for their use of e-mail and web technologies if critical mass had not been reached for the infrastructure necessary to use those information technologies. Research hypothesis one compared the frequency of combined SCDE faculty user and student user institutions which had access to adequate information technologies infrastructure with the frequency of combined SCDE faculty user and student user institutions which were identified as lacking adequate information technologies infrastructure. To facilitate technology integration within education programs and courses, access to adequate infrastructure is essential to increasing technology use for faculty and students (Arms 1992; Awbrey, 1996; Boettcher, 1995; Cummings, 1995; DeLoughry, 1993; Novak & Berger, 1991). Results of the statistical analysis for SCDEs with adequate infrastructure concur. The frequency of combined SCDE faculty user and student user institutions who had access to adequate infrastructure was significantly greater than for those SCDE institutions which lacked adequate infrastructure.

The second research hypothesis was concerned with comparing the frequency of SCDE faculty user institutions which had access to adequate information technologies infrastructure with the frequency of SCDE faculty user institutions which were identified as lacking adequate information technologies infrastructure. According to Awbrey (1996) and Cummings (1996), access to appropriate infrastructure is essential to increasing technology use for faculty. Results of the statistical analysis for this study confirm the research of Awbrey and Cummings. The frequency of SCDE faculty user institutions which had access to adequate infrastructure was significantly greater than the frequency of SCDE faculty user institutions which lacked adequate infrastructure.

The final research hypothesis of this study was concerned with comparing the frequency of SCDE student user institutions which had access to adequate information

technologies infrastructure and the frequency of SCDE student user institutions which were identified as lacking adequate information technologies infrastructure. According to Arms (1992) and DeLoughry (1993), adequate information technologies infrastructure is essential if SCDE students are to increase technology use during their preservice education. Results of the statistical analysis for this study did not support previous literature. The frequency of SCDE student user institutions which had access to adequate infrastructure was not significantly greater than the frequency of SCDE student user institutions which lacked adequate infrastructure. The reader should note, though, that cell sizes for the 'no infrastructure' groups were extraordinarily low for the sample size of 465; only one nonuser with no infrastructure and nine users with no infrastructure.

Resmer (1997) states, "As information technologies become an increasingly central part of learning experiences for students throughout all disciplines, universities and colleges face a major challenge in ensuring that all students have access to the technological infrastructure that will enable them to realize its full potential to transform their education" (p. 12). Results of this research clearly support Resmer's position for SCDE faculty users and student users (combined) and for SCDE faculty users. The lack of statistical support for SCDE student users may be explained by the cell sizes for the 'no infrastructure' groups being extraordinarily low for the sample size of 465, possibly resulting in the lack of statistical difference (Marascuilo & McSweeney, 1977). An alternative explanation might lie in the combination of the innovation selected (interactive information technologies) and SCDE student user profiles. Interactive information technologies are relatively new innovations which are quickly diffusing (with considerable publicity) into American society and educational environments (Geoghegan, 1994). According to MacKnight (1995) and McCandless (1995), the students' awareness of the innovation through publicity, but lack of exposure to, or experience using, relatively new technologies may result in the ideal conditions and environment for the majority of student use and nonuse to be directly

correlated with institutional infrastructure. Consequently, SCDEs have very few institutions represented in the 'no infrastructure' categories.

The findings of this study strongly support DeLoughry's (1996), Geoghegan's (1994), and Green's (1996b; 1997) premise that higher education institutions have achieved critical mass for the use of information technologies and, more specifically, this research has documented that SCDEs have achieved critical mass for using information technologies and the existence of the necessary information technologies infrastructure for SCDEs.

Regarding critical mass, the results of the calculations indicate critical mass has been achieved at the institutional level for student use, faculty use, combined faculty and student use, and the provision of necessary infrastructure for e-mail and web technologies across SCDEs. Results indicate that the SCDE adoption rate (92%) has surpassed the overall higher education adoption rate (59%) cited in Green's 1996a and 1997 research. Additional data was collected with the SCDE Technology Survey which indicated that SCDE facilities (computer labs and classrooms) are quite adequate for the use and classroom integration of information technologies (Persichitte et al., in press). When information technologies hardware and software are available and have become a necessity for faculty productivity, the next logical development is the implementation and integration of information technologies in classroom use (Topp et al., 1993).

This study also investigated contingent innovation-decisions- whether the frequency of SCDEs which had reached critical mass for their use of e-mail and web technologies with adequate infrastructure differed from the frequency of SCDEs without adequate infrastructure. Chi-square analyses resulted in significant differences for the combined SCDE faculty user and student user institutions and also for SCDE faculty user institutions with adequate infrastructure. These results are typical of organizations (e.g., education) which have strong organizational commitment demonstrated by funding, visibility, support, resolve and knowledge related to the use of an innovation (Kanter, 1988). Results

of this study confirm that SCDEs which have provided the necessary infrastructure have greater proportions of users for combined SCDE faculty use and student use and for SCDE faculty use. Clearly, one contingency for these user groups was access to adequate infrastructure and the corresponding observed critical mass values reflect this contingent adoption-decision (Cummings, 1996).

The results of this study may have been skewed by some combination of the individual who completed the JDCS. The limitations noted in the Limitations of the Study section within Chapter I should be reviewed prior to additional investigations within SCDEs.

Suggestions for Further Research

There were several questions raised and many questions left unanswered by this study. This research study documents that SCDE faculty and SCDE students have achieved critical mass at the institutional level for the use of information technologies. SCDEs must prepare future teachers for classrooms that will almost certainly require the use of information technologies, and, to accomplish this, many SCDEs use NCATE guidelines to foster technology integration (Awbrey, 1996; Novak & Berger, 1991; OTA, 1995). NCATE has compiled twelve goals for the educational computing technology preparation of preservice teachers in education programs (NCATE, 1993). The goals include demonstration of computer knowledge and the effective use of computers in classrooms (Gideonse, 1992; Parker, 1993; Rieck, 1992; Warner, 1993; Wetzel, 1993). Further research is suggested to explore the degree to which SCDEs are currently meeting NCATE guidelines for teacher preparation associated with the use of information technologies. Additionally, this author recommends expanding this study longitudinally to document integration and contingency adoption-decision patterns related to the NCATE guidelines as the classroom integration of information technologies evolves.

This researcher also suggests further research in documenting the Levels of Use (Hall & Hord, 1987) of information technologies as SCDE students graduate and begin teaching. Preservice teachers who leave SCDEs understanding only the mechanical skills of

information technologies will require more staff development and support than those preservice teachers who leave with established routines (Dirksen & Tharp, 1996). This study established critical mass at the institutional level for combined SCDE faculty and students in the use of information technologies. Concerning contingency adoption decisions, this researcher recommends further exploration and documentation of the extent to which SCDE faculty adopt information technologies contingent on the type and amount of student use and, similarly, the extent to which SCDE students adopt information technologies contingent on faculty modeling and integration.

Additionally, this researcher suggests strategies for the increased integration of information technologies into SCDE classrooms: creating a technology plan, revising the information technology life-cycle plan, implementing faculty training programs, and establishing faculty incentive plans. These suggestions are related to the findings of this research as well as much of the research presented in the literature review and are intended to provide some simple administrative guidelines for furthering classroom implementation and integration of information technologies.

This researcher suggests that SCDEs which have provided (or are currently developing) the necessary information technologies infrastructure create an information technologies plan which focuses on classroom implementation and integration. This study confirms that the number of adopters at the institutional level of information technologies is high enough to ensure continued adoption of information technologies. As previously stated, SCDEs have provided the necessary infrastructure for high levels of use by combined SCDE faculty and students and SCDE faculty to adopt information technologies even though the adoption decision was contingent. Although SCDE student use at the institutional level (which was also hypothesized to be contingent on adequate infrastructure) did not indicate a statistically significant difference, ninety percent of all student user institutions were SCDEs with adequate information technologies infrastructure. Once adequate infrastructure is in place, faculty implementation and integration of information

technologies into the classroom is contingent on access to contemporary and reliable hardware and software, provided faculty have a reason to integrate information technologies into classroom instruction (Awbrey, 1995; Cummings, 1995, 1996; Denk et al., 1994; OTA, 1995; Wetzel, 1993). Consequently, SCDE administrators should consider refocusing their information technologies implementation plan on a life-cycle technology plan which includes faculty training components and faculty incentives for classroom implementation of information technologies.

Once SCDEs have achieved critical mass for information technologies infrastructure, there is an opportunity to progress from being hardware access centers to becoming information centers (MacKnight, 1995). The issue facing SCDE administrators is no longer whether faculty and students will use the technology but how they will use the technology in the classroom (Awbrey, 1996; Cummings, 1996). According to McCandless (1996), much of the existing information technology hardware and software is approaching obsolescence and requires a carefully considered life-cycle upgrade plan. Without such plans, faculty and students will fail to adopt classroom uses of information technologies because they lack access to reliable and compatible equipment or software. Administrators can overcome compatibility problems by establishing a three-year life-cycle funding plan which provides for updating or replacing information technologies equipment based on an amortized budget more appropriate for these types of capital investments (Awbrey, 1996; Boettcher, 1995; MacKnight, 1995; McCandless, 1995; Resmer, 1997).

The implementation of a SCDE faculty training program is another essential component of classroom information technology implementation. According to Boettcher (1995), for an individual's attitude, perception or behavior to change, they must experience new behaviors. Therefore, a hands-on training program which accommodates and updates individual faculty needs is a requirement for successful implementation (Bandura, 1986). Hale (1989) suggests faculty training programs should reflect (a) appropriate curriculum and training materials, (b) a training room with reliable equipment, (c) well-prepared

trainers, and (d) procedures that assure quality of instruction. Hands-on activities provide education faculty the opportunity to use technology that not only helps teach what normally could not be taught without technology, but eventually changes faculty perceptions of what is important to teach (Bandura, 1986; Boettcher, 1995; Denk et al., 1994). Knowledgeable faculty will be most important in implementing new curricula that take advantage of information technologies (MacKnight, 1995).

In conclusion, this researcher suggests that SCDEs create and implement an incentive plan that provides time and/or monetary incentives for faculty who use (or are learning to use) information technologies in the classroom. Currently, few institutions formally recognize or reward faculty efforts to integrate information technologies into instruction as part of the promotion and review process (Green, 1997). Time is a major concern of SCDE faculty. Preparation to use and implementation of information technologies requires significant knowledge, time, and initiative, which are often over-and-above the requirements of conventional teaching approaches (Cummings, 1995, 1996). According to Cummings (1995), a prime faculty concern is the loss of time that might be better invested in rewarded activities since the traditional faculty reward system in higher education is oriented toward research productivity. According to Green (1997), faculty conversations clearly indicate that faculty monitor the experiences of their colleagues who were early adopters of information technologies. Failing to promote, recognize, or reward faculty who have invested time and effort into the integration of these technologies within instruction sends a clear message to other SCDE faculty members about the value placed on technology integration within their role of teacher.

Summary

The results of this study confirm that adequate information technologies infrastructure is in place for SCDEs and use of information technologies by SCDE institutions has reached critical mass. Furthermore, critical mass at the institutional level for the use of e-mail and web technologies by combined SCDE faculty and students, SCDE

faculty, and SCDE students has been achieved. Additionally, combined SCDE faculty user and student user institutions and SCDE faculty user institutions with access to adequate infrastructure significantly outnumbered SCDE faculty and student user institutions and SCDE faculty user institutions without access to adequate infrastructure. Lastly, the number of SCDE student user institutions with access to adequate infrastructure did not differ significantly from the number of SCDE student user institutions with inadequate infrastructure.

This study has documented critical mass for SCDEs' use of information technologies at the institutional level and that SCDE user decisions are contingent upon SCDEs providing the necessary infrastructure to use information technologies. This researcher encourages others interested in critical mass and contingent adoption decisions to continue this line of study within larger contexts of education.

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APPENDIX A

SCDE Technology Survey

APPENDIX A

Institution ______________ INSTID: ______________ 1996 JDCS Addendum

School, College, and Department of Education (SCDE) Technology Survey

Please circle the scenario which **best** describes the **majority** (over 50%) of your SCDE faculty and student uses of and access to various educational technologies.

Student Use

1	Students are required to **design & deliver** instruction during student teaching which incorporates various technologies.	Students are required to **demonstrate** their use of at least one technology during student teaching.	Students have **no requirements** to incorporate technology within their instruction during student teaching.	Unknown
2	Students are required to take a course(s) on computer use, applications, communications, & **instructional integration**.	Students are required to take a course(s) on **computer applications**.	Students have **no course requirements** in technology.	Unknown
3	Students are required to **design & deliver** instruction on campus incorporating various technologies.	Students are required to **demonstrate** their use of at least one technology on campus.	Students have **no requirements** to incorporate technology within their instruction on campus.	Unknown
4	Students are required to use computers, televisions & VCRs to **share information** in the classroom.	Students sometimes use computers, televisions & VCRs to **share information** in the classroom.	The students **do not use** computers, televisions or VCRs in the classroom.	Unknown
5	Students are required to submit assignments using computer applications: **electronically or on a computer disk**.	Students are required to submit assignments completed using **computer applications**.	Students are **not required** to use a computer to complete assignments.	Unknown
6	Students are **allowed** to submit their work & ask questions via email.	The students **only communicate** with faculty via email.	The students **do not use** email to communicate with faculty.	Unknown
7	Students **may obtain** assignments & syllabi from a SCDE Web site.	Students **do not use** a SCDE Web site **to obtain** assignments & syllabi.	Students **do not have access** to a SCDE Web server.	Unknown

Faculty Use

8	The faculty **regularly** uses computers, televisions & VCRs as **interactive** instructional tools during class periods.	The faculty **occasionally** uses some electronic technology to **present** information during class periods.	The faculty **does not use** electronic technology during class periods.	Unknown

9	The faculty uses computers **occasionally** to conduct research & communicate with peers.	The faculty uses computers **primarily** for word processing tasks.	The faculty **does not use** computers for professional purposes.	Unknown
10	The faculty uses email to **collaborate** on projects & communicate with other faculty **outside** this institution.	The faculty primarily uses email for **communication within** this institution.	The faculty **does not use** email.	Unknown
11	The faculty uses the SCDE Web site to **display articles**, article abstracts & vitae.	The faculty uses the SCDE Web site to **display personal information** only.	The faculty **does not use** the SCDE Web site.	No SCDE Web Site

(Please continue on reverse side)

12	The faculty uses the World Wide Web to **search for articles**, article abstracts & vitae.	The faculty uses the World Wide Web to **search for personal information** only.	The faculty **does not use** the World Wide Web.	No Internet Hookup
13	The faculty **uses** distance education technologies for highly **interactive** (between sites or between faculty & students) instructional purposes.	The faculty **does not have access** to the types of technology that **allow for interactivity** between sites or between faculty & students.	The faculty **does not use** distance education technologies.	No Distance Tech.

<u>Institutional Capacity</u>

14	The administration **communicates** with faculty & staff via email.	The administration **does not communicate** with faculty via email.	The administration **does not have access** to email.	Unknown
15	Classrooms are **wired for Internet**, have televisions, VCRs & computers for instructional purposes.	Classrooms **have** televisions & VCRs available for instructional purposes.	Classrooms **have no** computers, televisions or VCRs available for instructional purposes.	Unknown
16	The SCDE delivers instruction to off-site students using **interactive technologies.**	The SCDE delivers instruction to off-site students using **computers, videos, text, or faculty travel.**	The SCDE **does not deliver** instruction to off-site students.	No Distance Tech.
17	Students have access to the **most advanced electronic technologies** and software applications.	Students have access to **basic** word processing, spreadsheet & presentation software.	Students **do not have access** to application software.	Unknown

18	The institution has **budgeted** a plan to purchase, replace & upgrade a variety of educational technologies.	The institution has a **plan** to purchase & upgrade specific educational technologies.	The institution currently has **no plan** to purchase or upgrade educational technologies.	Unknown

19 For the **budgeted technology** plans, please indicate the percent of funding from each of these sources:

____% State Funding ____% Institutional Funding ____% SCDE Funding
____% Grant Funding ____% Private Source ____% No Funds

20 Indicate the percentage of SCDE faculty/administration who have the following computers **on their desk**:

Macintosh	**Windows**	**Portables**	
____% PowerPC Macs	____% Pentiums/586/686	____% Macs	____% no computer
____% other Macs	____% other Windows	____% Windows	____% other computers

21 What percentage of the faculty/administration computers are **connected to the Internet**? ______%

22 Please complete this table by indicating the number of computers in each SCDE student lab:

Computer	**Lab 1**	**Lab 2**	**Lab 3**	**Lab 4**	**Lab 5**	**Lab 6**
PowerPC Macs	______	______	______	______	______	______
other Macs	______	______	______	______	______	______
Pentiums/586/686	______	______	______	______	______	______
other Windows	______	______	______	______	______	______
other computers	______	______	______	______	______	______

23 Are SCDE students **required** to purchase, or supply, their own computer? Yes No

Curriculum Vitae

Donald D. Tharp

Education:

Civilian

Degree	Year	Institution	Area of Study
Ph.D.	1997	University of Northern Colorado	Educational Technology
M.A.	1989	University of Philippines	Far East Studies
B.A.	1980	Michigan State University	History

Military

Year	Course	Location
1996	Air Command and Staff School	Correspondence
1987	Squadron Officer School	Residence
1986	Squadron Officer School	Correspondence
1983	Navigator Training School	Mather AFB CA
1983	Officer Training School	Lackland AFB TX

Work Experience:

Year	Institution	Position
1996-1997	University of Northern Colorado	Teaching Assistant

- Helped retrofit the graduate development lab with state-of-the-art multimedia equipment
- Instructed approximately 30 graduate students in uses of Educational Technology in the classroom
- College of Education Webmaster

Year	Institution	Position
1992-Present	United States Air Force Academy	Assistant Professor

- Department Head for Airpower Seminar- Honors Level
- Developed computer-based training modules
- Developed cooperative learning modules for Military Art and Science
- Taught Sophomore, Junior and Senior level courses
- Supervised 15 people in classroom implementation of technology
- Instructed approximately 100 aviation students in airmanship

Year	Institution	Position
1982-Present	United States Air Force	Major

- Chief Instructor and F-4 Weapons System Operator
- Supervised 10 people in scheduling aircraft and aircrew members
- Garnered 8 Top Gun awards